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H. M. S. BENBOW.

THE new armor-clad barbette ship Benbow, built by the Thames Ironworks and Shipbuilding Company, was delivered on the 26th of August into the charge of Captain Buller, at the entrance of the Royal Albert Docks, and proceeded in charge of that officer to Chatham Dockyard, where she will receive her armament, preparatory to being put in commission. The Thames Company, which is contractor to the Government for the supply of both ship and engines, has been working early and late to complete its contract within the specified time, and Messrs. Maudslay, to whom the contract for engines has been sublet by the Thames Company, being also under contract to complete by date, in order that the vessel might steam from the works down the river.

The Benbow is one of the six vessels of the Admiral class, so called from bearing the names of six of our famous admirals—Anson, Collingwood, Camperdown, Howe, Rodney, and Benbow. They are all barbette ships, the guns being mounted inside a fixed circular breastwork of thick armor plating, wherein the gun revolves on a turntable, and fires over the breastwork. The barbettes are placed one at each end of the superstructure, or midship battery, and the guns have each a clear range of 230 deg., viz., from 25 deg. abaft the beam to all round the bow or stern to 25 deg. on the opposite side, and converging upon an object on the broadside at about fifty yards.

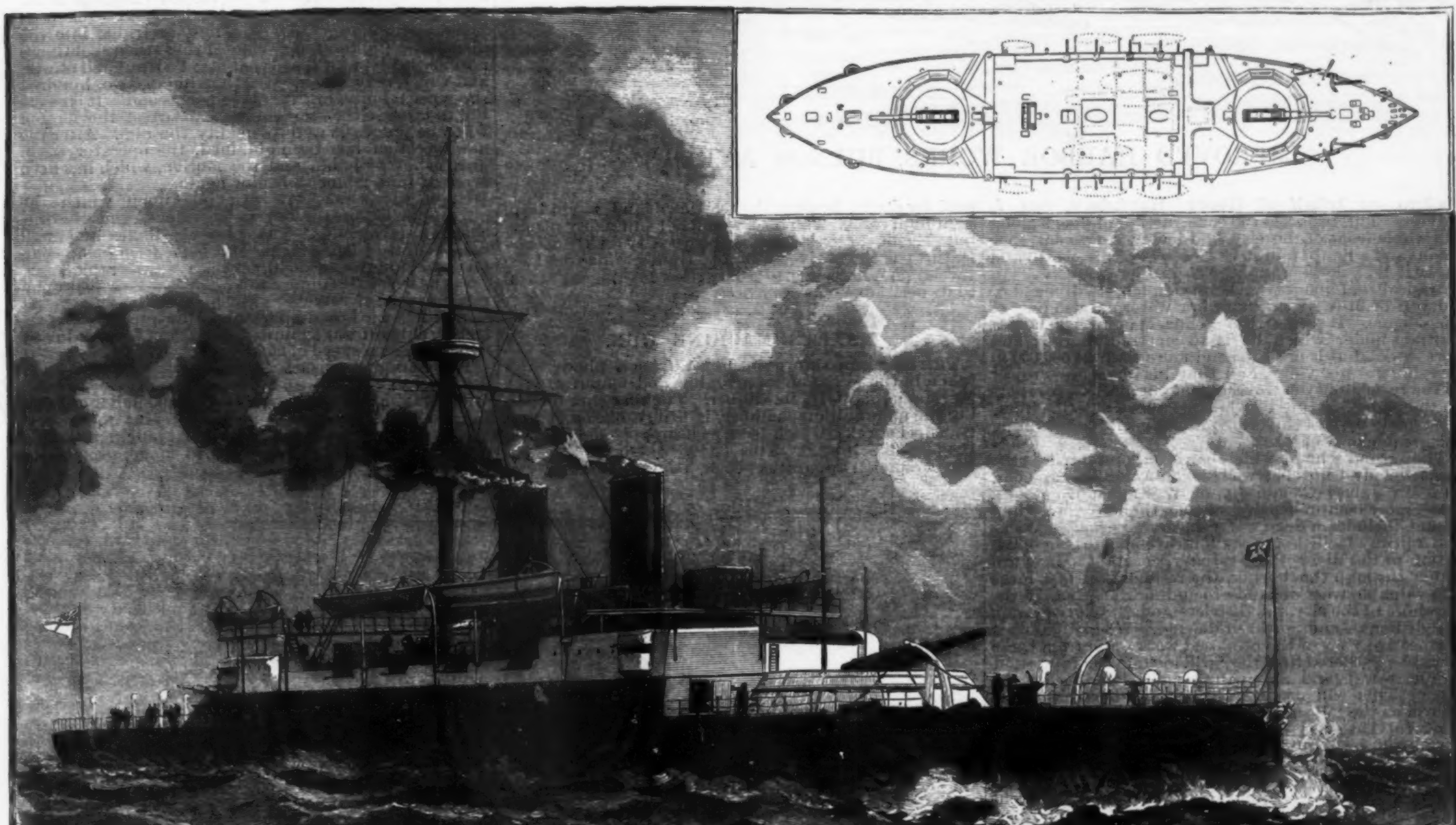
The Benbow has been chosen as one of the six vessels of this class to mount two guns of 110 tons each, one being mounted in each barbette; whereas, in the other five vessels, two guns are carried in each barbette, but of 63 tons only instead of 110 tons. These terrible engines of warfare would be most destructive in action, and are, in fact, formidable weapons, but in some quarters such enormously large guns are not viewed with much favor. England in the matter of adoption of such heavy guns has been following in the wake of Italy.

In addition to the two 110 ton guns, the Benbow carries a battery of ten 6 in. guns, twelve rapid-firing guns, and fourteen machine guns, these latter very conveniently arranged for use against torpedo boats. She is also fitted with four torpedo ports on the broadside and one through the upper part of the stern, all above water. The Benbow was launched on June 15, 1885, and has since that date been lying near the works, for the purpose of receiving her machinery and boilers, and for the completion of the multitudinous fittings of a modern ship of war. It would be impossible to describe on paper the character of such fittings, including the pumping, draining, and ventilating, some 189 separate compartments, each compartment being fitted with an automatic valve, where the ventilating pipe or trunk passes through, so that in the event of the water entering any one compartment, and rising to the height of the trunk—the trunk being assumed to be possibly damaged—the water would close the valve, and so be confined to the damaged compartment.

Some idea of the complication of the gearing in a modern war vessel as fitted in England may be obtained when we state that no less than 83 water-tight doors and armor deck shutters are fitted in this vessel, in addition to 85 water-tight doors that open and close by hand without gear. The deck plates, to which indicators are fitted, showing when each door or valve is open or closed, amount to no less than 250, in addition to the two automatic valves above named. Then, including the main engines, fan engines, pumping engines, electric light engines, steam steering and capstan engines, there are no less than forty separate sets all to be kept in proper going order, requiring all the care Mr. White, the chief engineer, and his able staff are able to bestow upon them. Mr. Yates, of the Royal Naval Corps of Constructors, has had the inspection of the Benbow, aided by a staff of assistants, to see that the company fulfills its contract; and any one comparing the Benbow with any of the sister ships will see that the full "pound of flesh" has been demanded and readily given, the Thames Company, ever since it built the Warrior, in 1861, having maintained its reputation as builders of first class naval constructions, and to this day retains its oldest connections in almost every nation.

The dimensions of the Benbow are as follows: Length, 330 ft.; breadth, 68½ ft.; and depth, 37 ft. The engines, supplied by the well-known firm, Messrs. Maudslay, Son & Field, are of the three cylinder compound type, of 7,500 indicated horse power, and reaching 9,000 with forced draught, giving an estimated speed of 16 knots. The Benbow, like other ships of this class, is of the citadel type; this means that the vital portion of the vessel for about half of her length is protected by being included in an iron box armored with 18 in. plates on the side, the top of which at full draught is 2½ ft. above and 5 ft. below water, giving a total depth of 7½ ft. The athwartship bulkheads forming the two ends of the citadel are 16 in. thick; before and abaft these there is an armor deck of 3 in. steel plating. Except for this steel deck, which is calculated to shield all below it from the fire of very heavy guns, the ends of the vessel are unprotected, and in a heavy engagement the superstructure would suffer severely. In the case of other types of war vessels, protection is afforded by a belt of armor plating all fore and aft, being thickest amidships and tapering toward the ends. But it is evident that all that could be done on the dimensions and displacement of the Benbow has been done; for in order to provide for the armor deck and additional freeboard of the Nile and Trafalgar, the displacement tonnage has had to be increased by 2,000 tons, making them 12,000 tons displacement instead of 10,000, as in the Benbow.

Recently, in the presence of Mr. Joshua Field and Mr. Hayward, the manager of the Thames Iron Works, the steam was for the first time admitted into the huge cylinders, when immediately the engines in both engine rooms started almost simultaneously, and continued steaming for three hours, thus showing that all was in perfect order and the vessel capable of making her short cruise to Chatham. The Sans Pareil, a sister vessel to the Renown, building at Newcastle, a vessel of somewhat similar dimensions to the Benbow, is making rapid progress at these works, and is to be



H. M. S. BENBOW, TWIN SCREW ARMOR-PLATED BARBETTE SHIP.

launched in the spring of next year; some 3,000 tons of material being already worked into place on the slip previously occupied by the Benbow, sixteen of the massive armor plates already in place weighing twenty tons each. The huge wrought iron sternpost for the new Italian armorclad Re Umberto is being forged and machined at these works also, which, considering the dearth of work everywhere, appear to be fairly busy.—*The Engineer.*

BUENOS AYRES PORT AND HARBOR.

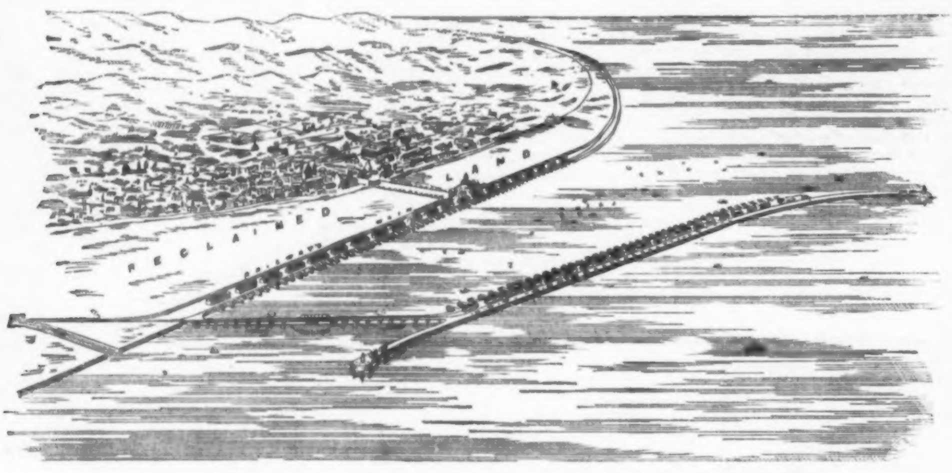
THE city of Buenos Ayres urgently requires some extensive port and harbor facilities, and various proposals have from time to time been made by English engineers and those of other countries. The port works question is just now very much to the front, and it seems that two separate and complete projects have been under comparative discussion. The plans of one of these were presented to the Government by Senor Madero on behalf of Messrs. Hawkshaw, Son & Hayter. This proposes the construction of docks along the whole front of the city, and includes two entrance basins and a line of four docks, each 525 ft. in width and excavated along the foreshore to a depth of 24·5 ft. An entrance canal about twelve miles in length, dredged to a depth of 21 ft. at ordinary low water, is also part of the scheme. It seems that Senor Madero has now a contract under which he is to construct harbor and port works, but is not to spend more than £4,000,000 in carrying out his views, and that his plans are subject to the revision of the Government engineers. A report on the plans presented by him, as above described, has been made by the Government engineers, condemning the greater part of it.

The second scheme which has been presented is the project of Mr. Church, a well known American engineer, and Mr. James Cleminson, of Westminster. It is a much more comprehensive scheme than any preceding it, and includes a deep water harbor as well as docks and railway facilities, great improvement of the navigation of the River Plate estuary, constant current of water through the harbor, the reclamation of a large and valuable tract of land—including the whole of the foreshore of the city and district—and the construction of lighthouses and works of defense. We give above a perspective view of the proposed works, and from these it will be gathered that they will include the formation of a narrow island, about three miles long, facing the city. This will occupy the inner edge of what is known as the "Boca Bank," and will be flanked with powerful batteries mounted with heavy guns. The island will be about 350 ft. in width, and will provide a fine sea boulevard and promenade about 80 ft. in width running its entire length.

Projecting from the inner side of the island numerous piers will accommodate shipping, which will be perfectly sheltered from the severe southeastern gales which sweep up the Plata. Along and near the river wall, and next to the piers, will be a line of storehouses for imports and exports. Railway tracks in front and rear of the storehouses, and on the piers, will give facilities for the economical handling of goods. At the northern end of the island will be a navy yard, with marine slips for ships of the largest tonnage that can ascend the river. Nearly parallel with the inner wall of the island, and about seven-eighths of a mile from it, will be the city wall. Between this and the present beach a large area of land will be filled in from the harbor, which is to be excavated between the city wall and the island wall. The area reclaimed will be about 1,200 acres, to be laid out in boulevards and streets, and serve for the extension of the commercial part of the city. Numerous piers will be pushed out from the city wall into the harbor to serve for the already immense river traffic, and behind these piers will be the line of storehouses for the internal commerce. To the rear of the storehouses, and along the entire frontage, will run the numerous railway lines from Buenos Ayres; and, midway of the city front, a grand central station will be built, where all the railways of the country can be accommodated. The city portion of the works will be connected with the southern end of the island works by a broad bridge, carrying railway and tramway tracks, a carriage road, and foot walks. It will have a double swing bridge in its center, to connect the harbor with the deep channel which leads to the Riachuelo port works.

The northern end of the island and its works are designed so as to catch as large a body of the river as possible and throw it through the harbor. This it is proposed to excavate to a depth of 10 ft. below low water on the city side, and to be gradually increased toward the island, or foreign commerce, side until it has a depth of 21 ft.; and it is expected that this will be materially helped by the scour of the deflected southern part of the Plata current. The estimate of dockage room is 19,600 ft. lineal for foreign commerce, and the same for the coasting or river traffic, but this may be augmented with facility and at little cost. The area of the harbor is 1,800 acres.

Messrs. Church & Cleminson have departed radically from the stereotyped notions as to the relation between ports and docks. There are at Buenos Ayres peculiar conditions, which, no doubt, require special plans and a departure from the ordinary way of making a port by constructing docks. Docks at Buenos Ayres could only be approached at certain times, access would be often impossible, owing to the periodical winds, and the infrequently changed water of a dock would sometimes become a nuisance. A harbor easily entered in all weathers would obviously possess very great advantages, not only as a commercial port, but as a harbor of refuge also. There are thus weighty reasons for thinking that the project of Messrs. Church & Cleminson is specially worthy of commendation, one that we have not mentioned being that it would cost the Government no more than would have to be paid for docks, because the reclaimed land would be of such high value. The plan would not suit many places, but Buenos Ayres is a seaboard city with special features as to its river and sea shores, which make a special plan necessary to secure the advantages natural to its position.—*The Engineer.*



IMPROVED HARBOR WORKS, BUENOS AYRES.

MAXIM'S MACHINE GUN.

THE new gun shown in Fig. 1, from a photograph taken in the works of its inventor and manufacturer, Mr. Maxim, is of 1½ in. caliber. The rear end, including the ammunition chamber, is firmly fixed between two steel cheeks, which serve as a support and guide to the movable breech. This latter, which contains all the percussion apparatus—cock, trigger, tumbler, etc.—is called movable because it is capable of sliding under the action of a crank shaft that revolves between the cheeks. With this shaft is connected a winch, by means of which the operator maneuvers the entire mechanism of the breech with the greatest ease. The cheeks and barrel are so arranged as to slide in a bronze jacket, of which the trunnions form a part. These latter rest in a pivoting support, whence it follows that the range measures 360° in extent. As in the self-acting machine gun of the same inventor, the 1½ in. shell cartridges of this cannon are inserted, one after another, in a canvas belt, to which they are separately affixed by flaps. All the parts, as well as the ammunition, are within easy reach of the gunner. We say *gunner* advisedly, since it takes but one man to maneuver the apparatus, and he needs to use but one hand to do so.

The firing may be done in two ways, viz., by hand or automatically, and that too at will. In the first case, the gunner has only to maneuver a tumbler independent of the breech. In the second, the piece is actuated by the crank shaft, which itself moves under the action of the force of recoil. If it be desired to do the firing automatically, it is necessary, moreover, to prime the piece, that is to say, to fire the first shot by hand. Let us see, then, how things proceed? The gunner maneuvers the winch of the crank shaft, that actuates the entire mechanism of the breech, and introduces into the gun the first shell of the cartridge belt. The loading having been done, he acts upon the tumbler, and the gun goes off. What happens? Immediately after this first projectile starts, the gun is submitted to a recoil, as are also the cheeks, which, as we have said, are capable of sliding in their jacket. The recoil afterward acts upon the shaft, which then makes two complete half revolutions. During the first of these, the movable breech moves backward, extracts the spent shell, and takes into the distributer a loaded cartridge. During the second half revolution, the empty shell is thrown out, the loaded cartridge is introduced into the gun, and the latter returns to its place, putting, as it does so, a new cartridge into the distributer; and so on. The firing then continues automatically, at a speed that may be regulated at will, and which may reach, at a maximum, two hundred shots per minute, or over three per second. It is essential to observe that the gunner can arrest the motion when he judges it well to modify the aim. After the new direction has been obtained, the operator again fires a shot by hand, and the motion, which has been arrested for a moment, begins again.

Upon the whole, the principle upon which the apparatus is constructed is ingenious, and the mechanism is simple. The piece is light, and well balanced, the maneuvering of it is far from being complicated, and the automatic firing proceeds rapidly.

This 1½ in. Maxim machine gun will be called upon to render great services, principally in the navy. It is well known how important is the problem of protecting ships of war against the attack of torpedo boats, which sail at a speed of 25 knots.

This new gun satisfies all the requirements of such defense.

Mr. Maxim is constructing two other similar guns, of 1¾ and 2 in. caliber, and at the present moment is manufacturing one of 4¾ in., which, judging from the results of the experiments hitherto made, promises to behave well.—*La Nature.*

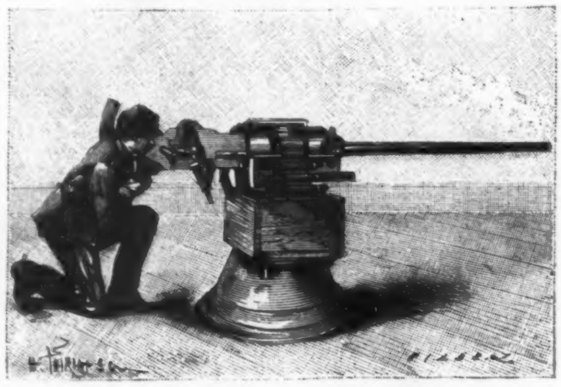


FIG. 2.—MANEUVER OF THE MACHINE GUN.

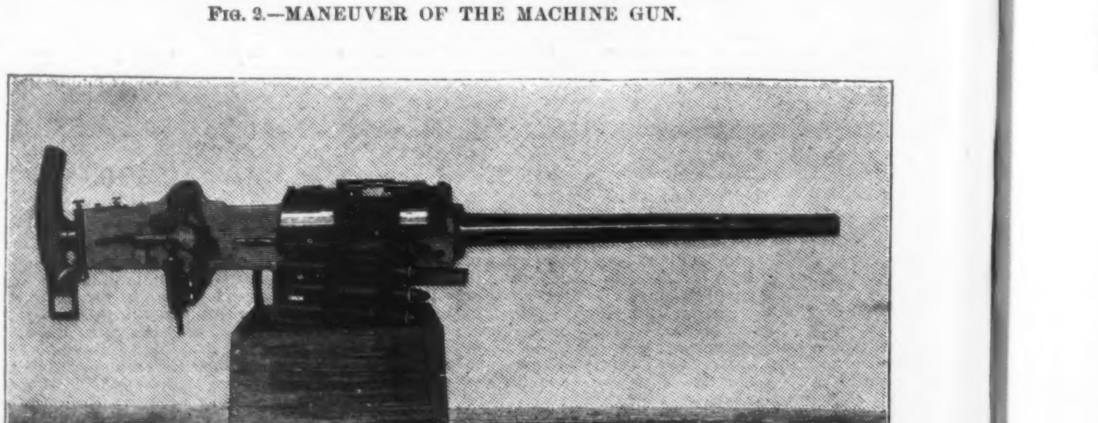
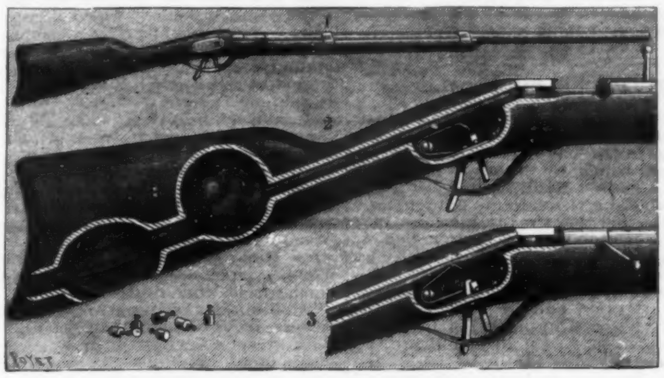


FIG. 1.—MAXIM'S MACHINE GUN.

AN AIR GUN.

A LARGE variety of guns for children is to be found in toy shops; but, as a usual thing, these instruments are not adapted for a study of and practice in firing, and can only serve for amusement. The majority of these toy guns are incapable of throwing a projectile, even to a slight distance, with anything like accuracy. If we wish to teach a child to fire at a target, it is necessary to have recourse to rifles that require the use of fulminating capsules or of highly compressed air. The projectiles in this case are shot with force and precision to a great distance; but the guns are not safe. These genuine arms may prove dangerous in the hands of inexperienced persons, and, besides, have the drawback of being costly. The little gun which is shown in Fig. 1 appears to supply a want in this line. It has been devised by one of our collaborators and friends, Mr. Mareschal. This ingenious little device holds an intermediate position between the useless toy and the dangerous plaything. It operates through compressed air; and the pressure, which is but slight, is obtained by means of the rubber apparatus that we all know from having seen it operate in perfumery vaporizers. This apparatus is very deftly concealed in the butt end of the gun, as shown in Fig. 2. A small aperture at the extremity permits of pressing the finger against the air pump. Before air is stored up in the elastic bulb, it is necessary to shut off its exit. To this effect, the second trigger, which passes through the guard, is pressed forward. As seen in Fig. 3, this trigger forms the extremity of a spring which flattens the rubber tube that leads the air to the barrel. This spring, when once compressed, remains locked until the trigger is pulled. At this moment, the tube, being freed, drives the projectile before it as in a pea shooter. The projectile, a few specimens of which are figured to the left in the engraving, is simply a small wooden cylinder at the extremity of which is fixed a round-headed nail for balancing it. It is introduced through the breech, which is opened by means of a lever, as in needle guns. The range is from 12 to 15 yards; but, in order to fire with accuracy, not more than half that distance must be exceeded, that being entirely sufficient for practice in firing at a mark, and being the distance usually adopted in shooting galleries.



AN AIR GUN FOR CHILDREN.

Mr. Mareschal's gun is essentially an affair for apartments. A sheet of paper placed against a wall forms a mark on which the projectiles leave a perfectly distinct trace, because they strike it nail-head foremost. If, in spite of this, any one wishes to assure himself that there is no danger, he can fire at his hand, and find that the projectile does not hurt him.

We think that at our epoch, in which shooting societies are daily increasing, this implement will be able to render genuine services. It will permit children to become accustomed at an early period to firing at targets, and will thus prepare them to become good marksmen and soldiers.—*La Nature.*

STEAM BOILERS WITH GASOGENE FURNACES.

MESSRS. ED. ALBIN & Co., of Strasbourg Neudorf (Alsace), are the makers of a new system of boilers with gasogene furnaces, which we are enabled to illustrate herewith, in front elevation and longitudinal section. The makers claim by their system to have reduced the cost of producing steam to a minimum, and certainly, if some of the published results are reliable—and we have no reason to believe they are not—their claim is in all respects a fairly substantial one. The foundation of it appears to rest upon the fact that for fuel—coal and coke being dispensed with—all sorts of waste matter may be employed, sawdust, wastewood, peat, moist tan waste, moist dyewood, refuse, etc., and these in a much less degree than with a boiler which, in addition, burns coal. Another advantage is that the furnace only requires serving about every twenty minutes, and during the intervals the stoker can be going on with other work. For instance, at one saw mill fitted with this boiler the stoker sharpens all the saws necessary for the mill. Fig. 1 shows the front of the boiler. It will be noticed that it consists of two plates the upper one of cast iron; while the lower, being subject to a high temperature, is made of wrought iron, and is about ⅝ in. thick. The makers claim that these plates never crack, while they allow the face of the boiler always to be kept clean. M^1 M^1 are the two regulators of the cold air which circulates through the brickwork on its way to the hot air distributer. The two doors, A^1 A^1, permit of easy clearing of soot from the tubes. C^1 is the furnace door proper, which is raised vertically by the action of the lever, D^1, communicating with a pulley balanced by counterweights. Underneath C^1 is the ashpan door. The removal of the ashes is further facilitated by a sheet iron plate fixed on the floor in front. Fig. 2 shows a longitudinal section of the boiler and furnace. A B is a large inclined grate, the iron bars of which are arranged to admit of the free passage of air through the fuel, without any of the latter falling into the ashpan. At the extremity of A B is a horizontal grate, C, supported on two frames, which can slide forward and allow the ashes to drop when cleaning is required. Below, and parallel with the inclined grate, is the hot air distributer, D E, consisting of a rectangular box, with revolving shutters of the same width as the grate. The openings of these shutters correspond with the openings between the bars of the grates. The hot air distributer is supported on each side by trunnions, F, which, besides admitting air, allow the distributer to be instantly lowered by means of a small windlass, K, when the bars require cleaning. Turning to the working of the furnace, it will be seen that the cold air is admitted by the regulators, M^1 M^1, passes through the flues, L L L, as shown by the arrows, enters the chamber, the top part of which is heated throughout its whole length by the furnace flame, passes in small quantities under the horizontal grate, C, and enters the trunnions of the distributer by the lateral flue, L L F, whence it is distributed at a very high temperature by the shutters underneath the grate. The air traversing the incandescent fuel stimulates combustion, and mixes with the gases. The vaulted shape of the upper part of the furnace favors this coalescence in the space, L, above the grate. The gases subsequently contract in P, and then cross the fire bridge, where, there being a much larger space, expansion takes place freely. They afterward proceed along the barrel of the boiler, return through the piping, and rejoin the flue after superheating the top of the barrel. To show how completely the heat is utilized, we may mention that the gases, on reaching the entrance to the chimney, scarcely register more than 260° F.—*Industries.*

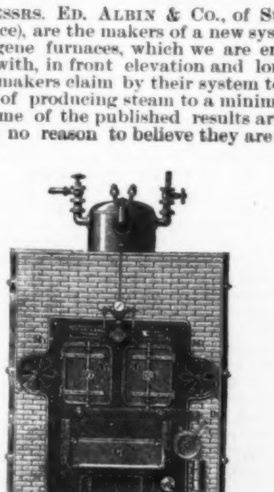


FIG. 1.

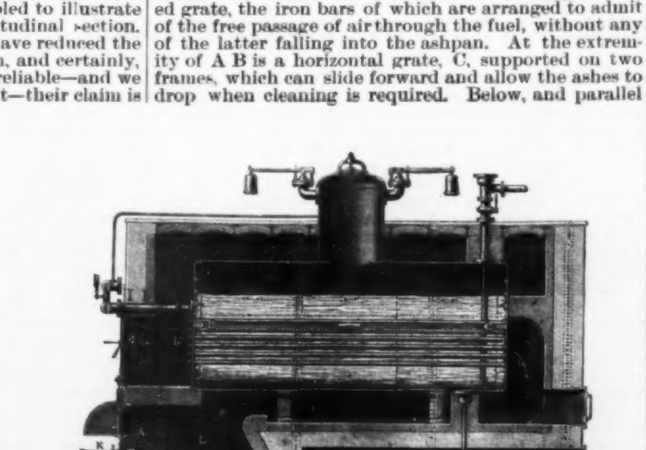
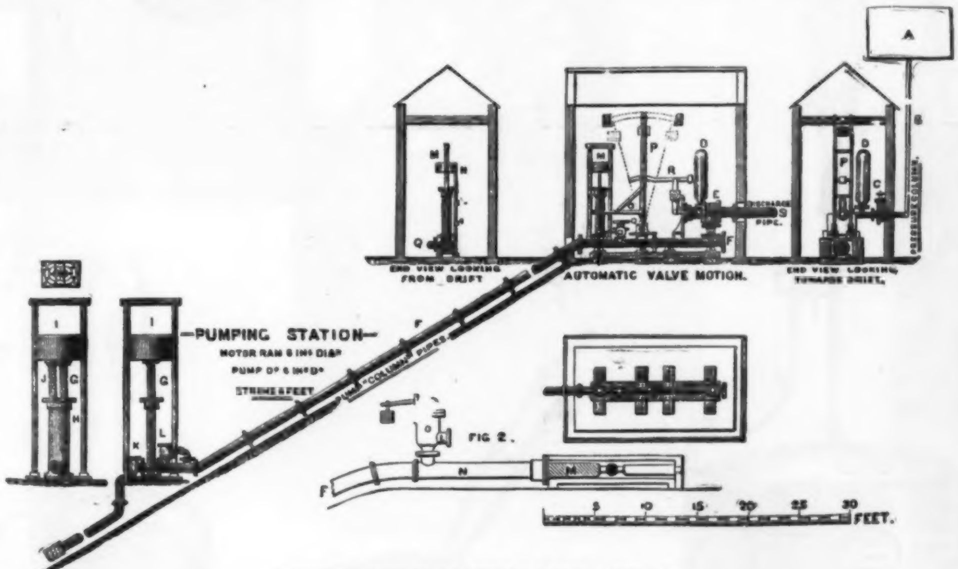


FIG. 2.

STEAM BOILERS WITH GASOGENE FURNACES.

HYDRODYNAMIC PUMP.

IN the following illustration of Messrs. Teague & Thomas' invention, of Neath, at a higher level than the top of the slant is a tank or reservoir, A, supplied with water from the main pump of a pit or from a mountain stream or any other means that will give the necessary supply. The pipe, B, from this source of supply is provided with a suitable valve, C, by means of which a regulated quantity of water may be passed from under an air vessel, D (if desired), through an equilibrium valve placed in casing, E, and thence down the slant pipes, F, where the pressure acting on accumulator ram, G, working in cylinder, H, raises a ballast box or weight, I, attached to which is the pump ram, J, which, rising with the ballast box, draws in through the one-way valve, K, enough water to fill its pole case, the water from the slant pipe, F, being prevented from passing to the pump case by means of one-way valve, L. While this action has been taking place at the bottom of the slant, the pressure from the water supply, A, has through pipe and valve, Q, also raised a second ballast box or weight, M, at the top of slant. Attached to this second ballast box is a plug rod or other actuating source, N, by means of tappets, on which the arm, O, of a tilting lever or pendulum bob, P, is gradually thrown over, and this action through connected levers, R, is made to close the equilibrium valve in E, so cutting off the pressure supply, and opening the eduction branch, S. The pressure in the slant being thus reduced, the ballast boxes, I and M, both fall, owing to the action of gravity, and the volume of water used in lifting ballast boxes and the volume of water corresponding to that pumped from the sump by pump, J, is discharged at slant head, S. As the top ballast box, M, falls, the tappet on attached plug rod, N, acts on the arm, O, of the lever or pendulum bob, P, which through levers, R, closes the eduction branch, S, and opens the supply pipe from under D, and the entire operation is repeated. Where a constant supply of water, as at A, is not readily obtainable, steam or other power can be applied to work the pump, and the necessary arrangement of parts for this purpose is indicated in Fig. 2, in which is represented a pole or piston, M, adapted to be actuated by steam or other driving power—the said pole, M, working in casing or cylinder, N. The operation with this arrangement of parts is as follows: It being assumed that ballast box, I, and loaded valve, O, are down, and the pole, M, at its full out-stroke, with slant column, F, and pole case, N, full of water, power being applied to pole, M, it commences its in-stroke, forcing the water in F into cylinder, H, the ram of which raises ballast box, I, with its connected pump piston, J, and thus causes the pump cylinder to be filled. When G and J are at their full out-stroke, pole M has only reached half its in-stroke, the remaining half of which is utilized to raise loaded valve O, which is weighted to a few pounds more per square inch than the pressure required to raise ballast box I, the remaining portion of water in N being then forced out through discharge pipe L in valve O. As the pole, M, travels



THE HYDRODYNAMIC PUMP.

out the pressure is withdrawn, and the partial vacuum formed behind the pole causes case N to be filled with water from the slant corresponding to the amount discharged from under accumulator ram G, combined with that pumped by J, and the parts are in position to repeat their former functions.—*Colliery Guardian.*

THE LUCIGEN.

We illustrate a new system of lighting, designed for use in large open spaces, such as docks, shipyards, etc., and also applicable for use on board ship, and for industrial purposes generally. The "Lucigen," as the new system is aptly named, is the joint invention of Mr. James Lyle and Mr. J. B. Hannay, and is manufactured by Hannay's Patents Company, Limited, of 67 Great Clyde St., Glasgow.

"Lucigen" is in use at the Forth and Tay Bridge works, and other prominent places.

As will be seen from Fig. 1, the apparatus consists essentially of a tank, or reservoir, having a vertical pipe leading to the burner. Into the tank is placed a sufficient quantity of a heavy hydrocarbon oil (the waste product of gas, chemical, and oil works, obtainable at a nominal price), and this is forced by means of compressed air, under a pressure of 10 or 15 lb. per square inch, up the vertical pipe to the burner, where it is met by a stream of air introduced at the annulus shown surrounding the burner. By this means the oil is subdivided into a minute spray, and when lighted burns as a large solid flame, and, as all the particles are thoroughly consumed, there is an entire absence of smoke or smell.

The larger sized "Lucigen" gives a light equal to 2,500 candles, actual, with a consumption of about two gallons of oil per hour, which would provide ample light over a space having a radius of 150 yards from the light as a center, and that without any of the defects incidental to electric arc lights, or any other light where the maximum of intensity is obtained in the minimum area of effluence, with the resultant dark

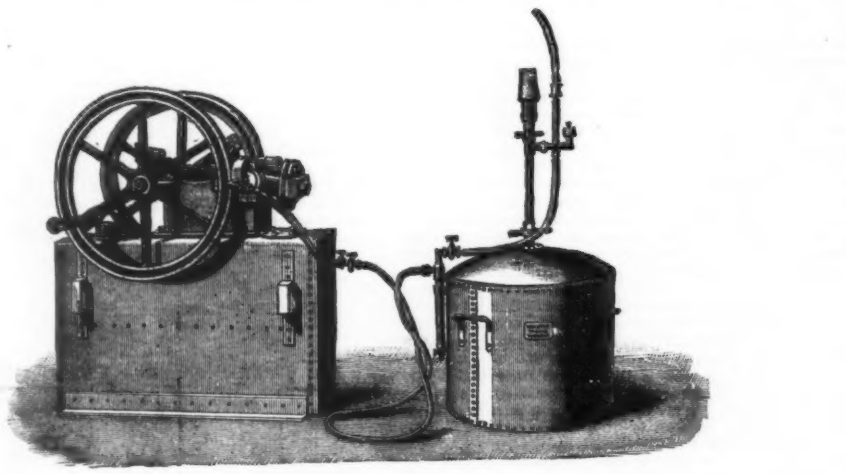


Fig. 4.

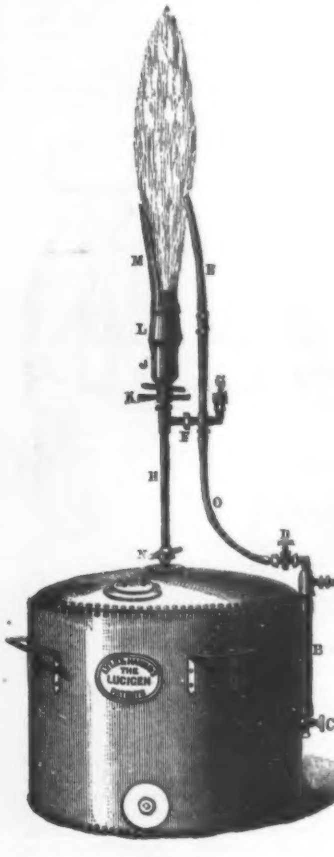


Fig. 1.

Fig. 2.

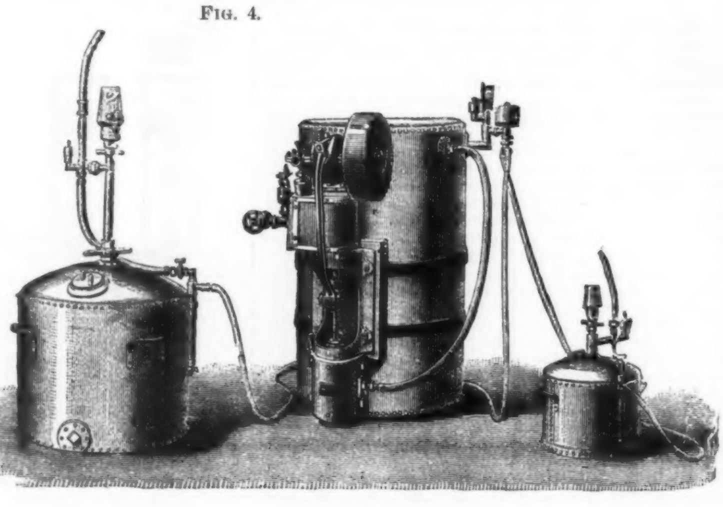


Fig. 3.

THE LUCIGEN.—A NEW ILLUMINATING TORCH.

shadows and straining of the optic nerves. In this respect the "Lucigen" may be well compared to a miniature sun diffusing a glowing, rather than an intense, light over the space to be illuminated.

The light is perfectly portable, will burn in wind or rain, and under cover or out of doors.

Fig. 2 shows a modification of the lamp, in which the flame is caused to issue at an angle, so preventing any black shadows being cast below. A horizontal flame lamp is also made for throwing a powerful light low down to illuminate the bottoms of ships in dry-dock, and a bracket lamp for lighting up large workshops, in which a central oil tank supplies all the lamps, the air and oil being led by separate pipes to the various burners throughout the building.

The portable air compressor shown in Fig. 3 is capable, when worked by two men, of maintaining two lights each of 2,000 candle power, while the small combined compressor and receiver, Fig. 4, when developing one horse power suffices for lights giving an aggregate total of about 10,000 to 12,000 candles. The small "Lucigen" shown in Fig. 4 gives a light of about 300 to 400 candle power, and is chiefly designed for use in cases where a light is wanted close to the work in hand.

Where dry steam is obtainable, it may be used in place of the compressed air, the resulting light being nearly as good, and the inventors have produced a form of the apparatus in which the heat of the lamp produces sufficient steam for its own requirements.

In a paper read before the Philosophical Society of Glasgow, Mr. Hannay advocates the use of a "Lucigen" on board every vessel in place of the ordinary side lights, and as by this means the whole of the vessel, hull, spars, and funnels would be rendered quite as apparent as in broad daylight, we are decidedly of opinion that if such a light were generally adopted one of the greatest dangers of navigation (*i. e.*, night sailing) would be reduced to a minimum, if not entirely overcome.

Messrs. George Bargate & Co., of Barrow-in-Furness, have fitted their steamers Glenwilliam and Mary E. Wadham with the "Lucigen," and they testify to their value for loading and discharging at night.

The apparatus is to be seen in use at the Liverpool Exhibition near the tobogganing slide.—*Marine Engineer.*

A SULPHITE PAPER PULP MILL.

For many years experiments were made with a view to obtaining a flexible fiber from wood, which should take the place of rags in the manufacture of paper. A process was discovered which, by the use of bisulphite of lime, obtained the desired result; but it was found impossible to manufacture the sulphite pulp in any quantity, owing to the fact that the bisulphite of lime was too powerful an acid to be used in iron boilers An attempt was made to overcome this difficulty by lining the iron boilers or digesters with lead, but this was attended with enormous expense, the lead linings requiring constant attention and frequent renewals. In 1879, however, Professor Alexander Mitcherlich, a skillful German chemist, succeeded in manufacturing a brick which successfully resisted the action of the acid. A patent was obtained on the manufacture of these bricks, to the use of which the process we are describing owes its success. The boilers in which the wood is acted upon by the acid are lined throughout with those bricks. Several mills using this process were soon erected in Germany, and have revolutionized the paper trade in that country. The process having been patented in the United States, the right to erect and operate a certain number of mills in this country was purchased by a number of capitalists, among whom, fortunately for Alpena, Mich., were the members of the lumber firm of Fletcher, Pack & Co., of this city. Owing to the abundance of the raw material here, it was decided to locate the first mill in Alpena, and, consequently, early last spring the work was begun.

The mill just completed has been built in a most thorough manner, under the careful oversight of Waldemar Thilmany, who made a systematic study of the process in Germany. The mill, which is situated on the east side of the river, consists of several buildings. The first building from the street contains the large engines which furnish the power and the steam; it also contains the saws which prepare the wood. The material used here is the pine slabs from the mill, a kind of wood that has never been used for the purpose before. As thousands of cords of these slabs are burned here every year, simply to get rid of them, the supply of raw material is assured.

The slabs are taken from the saw mill to the end of the building just mentioned, when they are taken by an elevator to the second floor. Here the slabs are sawed in two, crosswise, and are then embarked on an ordinary barking machine. They are then taken to tables where fine saws are running, and sawed crosswise into pieces one inch and one-quarter in length. The waste material falls into elevators, and is carried to the boilers. The blocks are carried by an elevator to the third floor of the second building, which is the sulphite mill proper. This building contains the immense boilers or digesters in which the acid acts on the wood, and also the wash room where the fiber is cleansed. As the pieces of wood are carried to the third floor of the mill, they are dropped upon the floor, which is kept very clean and neat. In the floor are the large manholes to the immense boilers, which occupy the second floor below, resting upon large iron beams. These digesters are 12 feet in diameter and 40 feet in length, capable of holding a quantity of sulphite pulp that will weigh three tons when dry. When filled, each boiler, with its contents, weighs 280 tons. The digesters are filled with coils of heavy lead pipe, which, filled with hot steam from the engine house, is used to heat the contents of the boilers. The blocks of wood are dropped down through the manholes, of which there are two to each boiler, into the digesters. When the digesters are properly filled, the manholes are closed, and the wood is thoroughly heated for about six hours by steam. The acid is then poured in through wooden pipes from the tank in which the acid is stored. Wooden pipes are used, as the acid does not affect wood, except when heated.

The formation of this acid is an interesting process. Towers about one hundred feet high are erected, and filled, except a few feet of open space at the bottom, with porous limestone. Porous limestone is used, in order to give greater surface for the action of the sulphur vapor in forming the bisulphite of lime. There are not many places where this porous stone can be found, that used here being brought from Sedalia, Ohio. At the tops of the towers are tanks filled with water, forced there by the pump in the engine house. By an ingenious contrivance, a spray of water from these tanks is allowed to fall continually over the limestone, and drip down slowly through the stone toward the bottom of the tower. Near the base of the tower is the sulphur house, and an oven for burning the sulphur. This is kept constantly burning; and as the sulphurous vapor passes off, it is carried up iron pipes about eighty feet high, and back again, in order that it may cool. After passing through these pipes and cooling, it is allowed to escape into the bottom of the towers containing the moist limestone. Here the action of the sulphur on the lime and water forms the bisulphite of lime, which is deposited at the base of the towers, and passes off into a wooden tank in a building near by. From this tank, when partly filled, it runs into an iron tank lined with lead, which is tightly closed, except the pipes. From this tank it is forced by pressure, supplied by the air pump, up into the wooden tanks above the boilers, in which it is stored ready for use. The air pressure is necessary from the fact that no machinery can be used in contact with the acid.

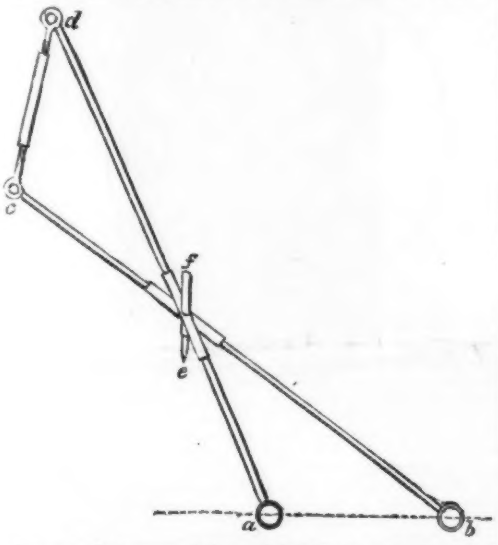
The acid having been poured into the digesters upon the heated pieces of wood, is itself heated, and allowed to remain about thirty hours. It is then drawn off; the lower manholes, on the bottom of the boilers, are opened, and the sulphite fiber—for such the wood has now become—falls out upon the floor. The remainder

of the process is simply for cleansing purposes and for breaking up the junks of fiber. For this purpose it is thrown into an elevator, which carries it to the wash room, where it falls into a long, narrow tank. Over this tank, extending the entire length, is a row of wooden stamps, which fall upon the fiber, two at a time, and force it along the tank, at the same time separating the fibers. From this tank it goes into a trough, the bottom of which is filled with depressions for catching the sediment, and is cleansed with clear water. From this trough it passes to a round tank, from which it flows through a pipe near the top into another tank. The pipe is placed near the top in order to prevent any sediment from passing along with the fiber. From the latter tank the fiber is raised by a cylinder fitted with an endless screw, and thrown into another tank. The water has now largely disappeared from the fiber, and it is forced along a series of tanks until it reaches the rollers, when, being of the proper consistency, it is rolled out into sheets, which are cut into convenient size for shipping.

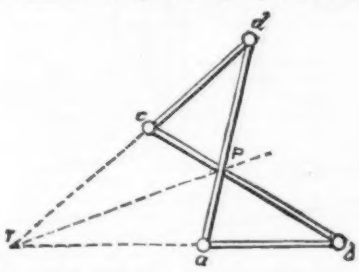
The mill employs a force of about thirty men, and manufactures about twelve tons of sulphite fiber a day. This fiber sells readily at five and one-half cents per pound to paper manufacturers, who make from it all kinds of paper, from the coarsest wrapping to the fine writing. The coarse papers and prints are made by mixing the fiber with from 70 to 90 per cent. of ordinary pulp.—*Alpena (Mich.) Pioneer.*

AN ELLIPSOGRAPH.

THE pencil, *e*, is fixed in a socket, which is fast to the under slide; the handle, *f*, is similarly attached to upper slide. The link, *c d*, is formed in three parts—



i. e., a socket screwed through half its length with a left hand thread, and through the other half with a right hand thread, into which are screwed the two joints working on the ends of the links, *a d* and *c b*. If the socket is turned one way the link, *c d*, will be shortened;



if it is turned the other way, it will be lengthened to suit any required foci.—*J. Riley, English Mechanic.*

NEW USE FOR THE RADIOMETER.

AT the last meeting of the Société Technique de l'Industrie du Gaz en France, M. Frère, Manager of the St. Quentin Gas Works, brought forward a proposition for employing the radiometer in gas works to indicate the time for putting on the night pressure. He said he had himself used the instrument in this way for some months, and had found it act satisfactorily. It was constructed in the usual way, viz., a glass globe in which four vanes, black on one side and white on the other, revolved almost *in vacuo;* the motive power being furnished by the increased pressure imparted to the air on coming in contact with the hottest part of the apparatus—that is to say, the blackened sides of the vanes. It is well known that as long as there is sufficient light the vanes will turn; but when the luminous rays become feeble, the rotary movement ceases. If the radiometer is exposed to the setting sun, the vanes stop, in very clear weather, about 20 minutes after sunset; and in very dull weather sometimes 30 minutes before sunset. In applying the peculiar property of this instrument to the practical purposes of a gas works, M. Frère recommended that the workman in charge of the governors should begin to put on the pressure five minutes after the stoppage of the vanes; and if this were done, the consumers would, he said, have a proper supply of gas at the moment they require it. By taking note each day of the exact time at which the radiometer ceased turning, the average time for lighting up could be determined at the close of the month. M. Frère thought that, without putting forward the indications of the radiometer as absolutely reliable, it would be possible to make good use of the monthly averages. These, compared one year with another and with corresponding months, would enable gas managers, in certain cases, to give the consumers a reasonable explanation of any excess of consumption which might be the subject of complaint.

THE BATHYMETER.

THE instrument herewith illustrated is designed for taking flying soundings at sea; and as it does not depend for its indications upon the length of line paid out, but solely on the pressure of the overlying water, it follows that it always registers the exact vertical depth over the place where the instrument falls, regardless of any obliquity in its path due to the velocity of the vessel from which it is cast.

The reading is obtained from the compression of a hermetically sealed bronze chamber, which closes in direct proportion to the head of water over it. The chamber is connected by suitable means with a needle or index pointer, and this is moved over a graduated dial so long as the bathymeter is descending, but so soon as the instrument commences to ascend the needle is locked, and thus registers the lowest point obtained. A simple spring detent suffices, when pressed, to release the needle, and the instrument is then ready for another reading.

The bathymeter is extremely simple in construction, will register equally well in any position, and does not rely upon any tubes or air vessels in which the compression is measured by displacement, an operation far too delicate for rough usage.

All the parts are strongly plated, and so thoroughly protected from the action of sea water, while the line used for sounding is a thin wire cord of phosphor-bronze, which does not rust or corrode.

The windlass, with wire, bathymeters, and sinkers, etc., are all packed in a small teak box which forms the stand for the windlass when soundings are to be taken. The reel, made of brass, is provided with a powerful differential brake, giving the brakesman complete command over the wire, which is run out by a fairlead fixed on the taffrail. The whole apparatus is strong and well made, and can be easily managed by two men.

The bathymeter has been supplied to numerous vessels, and in every case it has been highly spoken of by the ships' officers.

Made by Hannay's Patents Company, Limited, of 67 Great Clyde St., Glasgow.—*Marine Engineer.*

THE BATHYMETER.

MAGNESIAN CEMENTS.

To the Editor of the Scientific American:

The SCIENTIFIC AMERICAN SUPPLEMENT, No. 567, contains an article written by MM. Leon Durand-Claye, C.E., and Delray on "Accidents due to the Use of Magnesian Cements in Masonry."

After citing several instances where expansion of masonry had occurred, they give us the analysis of the cement used, and close their article with the statement that "it may be asserted that all masonry in which cements of this nature are used is destined to be destroyed."

Were this article kept within the bounds of the country from which it emanated, we could view it complacently; but now that it has obtained a wide circulation through your columns, we desire the space necessary to point out the errors into which those people across the waters have fallen, and to defend, as far as we are able, the reputation of our own American cements, which, although indirectly, are yet seriously attacked—as the article in question cannot fail to cast suspicion on all magnesian cements, and it is well known that of the four and one-half millions of barrels of cement manufactured in this country during the current year, nearly four millions of it may be classed as magnesian cements, and this ratio will hold good for all the cements ever manufactured in the United States, and the work done with these cements in this country during the past fifty years should be a sufficient refutation of the absurdity of the deductions drawn by the writers in question.

The Brooklyn Bridge, the bridges across the Hudson at Albany, the three bridges across the Niagara, the great viaduct at Cleveland, O., the lake and river tunnels at Chicago, all the bridges across the Mississippi and Missouri Rivers, the great viaduct at Minneapolis, the lake tunnels at Cleveland and Buffalo, the old and new Croton aqueducts, all the bridges in New England and New York and the West—these and hundreds of other notable structures in this country were built with cement containing as much, and in many instances more, magnesia than the cement in question. Yet we do not hear of any "accidents" due to the presence of magnesia in the mortar, nor are there any evidences that these structures are "destined to be destroyed."

The writers to whom we refer found the masonry in several structures they had examined ruined by the expansion of the cement in the mortar. They also found that the cement used contained magnesia; then jump at the conclusion that to the presence of magnesia was due the whole cause of the disaster, and to prove their conclusions, they make the experiment of mixing free magnesia with some good cement and find it to expand, and then point it out as "the line of investigation for the special commission on cements in seeking the causes of the accidents described."

Allowing their table of analysis to be correct, the trouble did not arise through the presence of magnesia. Had the gentlemen used free lime instead of magnesia in mixing with a good cement, and found, as they certainly would, the same results as to expansion, what then could have been their conclusions?

The facts are that the magnesian cement in question did not contain sufficient silicic acid in its composition. Had the magnesia been removed and lime taken its place, in the cement used, expansion would have occurred just the same.

There was not a true combining ratio between the acid and the bases. There was an excess of free bases amounting to about 14 per cent., which without previous hydration were bound to displace the masonry. Had there been 5 per cent. more silicic acid and 5 per cent. less lime, leaving the per cent. of magnesia unchanged, there would have been no "accident due to the use of magnesian cement" to record.

Buffalo, N. Y., Nov. 25, 1886. U. CUMMINGS.

EDUCATION IN HANDICRAFT.

TWENTY years ago, it would have been considered absurd that any one should aspire to become a mechanical engineer without being a proficient in handicraft. All the great engineers of the past, and many of the then present generation, were first-rate mechanics, and were quite able to take a job out of the hands of any man in their shops, and do it as well as, if not better than, he. They had begun practical work at an early age, and the energy which had raised them to the front rank in their manhood had, while they were boys, urged them to excel their shopmates, and to attack every difficulty and become masters of every operation within the range of the establishment at which their apprenticeship was passed. They could mould, forge, fit, and turn; and when they became employers of labor, they not only knew how work ought to be done, but also knew how to do it. But since the time we speak of, a great change has taken place in the conditions of handicraft. The old-fashioned mechanic who could turn his hand to do everything, and not only execute the work, but design the greater part of the details, is growing extinct. Division of labor has killed him. Now his functions are divided among many men. The junior draughtsman produces the full-sized drawings which formerly were laid down on the attic floor of the works. The very mention of these chalk drawings seems to carry us back years and years. We recall the figure of the sturdy old mechanic, with his paper cap on his head and his spectacles on his nose, down on his hands and knees, the latter carefully protected by huge pads of carpet, transferring the sketches from his greasy old notebook to the wide expanse of the floor, while a young apprentice, his assistant, carefully saws up his block of chalk, hot from the stove, and pares down the slices to a fine edge. But now the old man is gone, and the lad can no longer learn from his sententious talk the reasons for adopting this or that method of construction. The productions of the drawing office go to the leading hand, who marks out the work for the machines, when it is cut to shape by a new type of mechanic, a specialist of the very narrowest culture, one whose field of usefulness is so small that sometimes it does not transcend the limits of a tiny screw or a trifling pin—a man whose intellect is dwarfed and stunted by a system which has achieved splendid results in producing accurate and cheap work, but which has been the moral and technical ruin of the craftsman. It is true that the fitter and erecter

still remains, but he expects that the work shall need little more than "assembling" when it comes into his hands; and if more be required than this, he sends it back to be replaned or turned, as the case may be.

And while this alteration has been taking place in the province of the worker, a still greater change has developed itself in the education of the professional engineer. He is no longer expected to spend years in the shop. Instead of that, he attends classes where he is lectured to by learned professors, and in a month he receives, and perhaps assimilates, the information which took his predecessors years to gather up for themselves. His time is so much occupied in the acquisition of book knowledge, to use a colloquial term, that he has but little opportunity for work in the shops, and even that little is turned to poor account, for modern machine work has taken all the zest out of handicraft pursuits. The parts of a machine now go together like the pieces of a Chinese puzzle, while the distinguishing marks they bear destroy the pleasure of finding out their proper relationship. It is, consequently, no infrequent thing to find a modern mechanical engineer destitute of manipulative skill.

Such a state of things is essentially unsatisfactory. Every engineer engaged in the design and manufacture of machinery should be a mechanic. Not only is this necessary to give him a firm grip of his business, and the respect and control of his men, but also for the sake of the mental training it supplies and the corrective it affords to the priggishness acquired in the class-room. This is generally admitted, and some who pose as educators of engineers propose to attain this end by mixing up workshop practice with the schoolboy period of life. Nothing, in our opinion, could be more ill-judged, or more likely to stunt the mind of the scholar at a period of life at which every effort should be made to expand it. The tendency of nearly every business and profession is to narrow the mind of him who practices it, unless he is possessed of a broad and powerful intellect. The attorney concentrates his attention on verbal flaws, until he misses the significance of the great principles on which law is founded; the artist becomes so critical of details of execution that he elevates technical skill at the expense of poetic conception; the engineer, bent on material progress, is a by-word for his disregard to beauty; the scholarly clergyman discourses on morals in well-turned sentences of the correct grammatical construction to a sleeping congregation, while the Salvationist can rouse his audience to enthusiasm without knowing a verb from an adverb. And so on through the whole catalogue.

The great object of education is to fortify a man against this influence, so that he may be able to stand upright with his head above the level of the fence which surrounds the little plot of land to the cultivation of which his life is devoted, and to look forth over the whole neighborhood in search of beauty and knowledge. To teach a schoolboy handicraft or mechanical drawing, because he is intended for an engineer, is to handicap and not to advance him in the race of life. By the time he is five-and-twenty, his hand, always resting on the straight edge and the set square, will have lost all freedom, and his mind will have come to regard straight lines as the ideal of beauty. The education of an engineer should rather be directed in the opposite way, so that his mind and his hand may be armed by an acquired ease and elasticity against the hardening and narrowing effects of his professional occupation. Therefore, as the school age is certainly the wrong time for ordinary mechanical training, and as the prevailing engineering curriculum, both in college and workshops, offers such poor opportunities for handicraft practice, it is worth while to inquire if there be no other way, beyond that generally in vogue, of acquiring aptitude in the use of tools, or at least of supplementing the short time usually spent in the works. If all our engineers were to pass their lives in first-rate establishments, such as Beyer, Peacock & Co.'s, or Penn's, or Clayton & Shuttleworth's, a very moderate amount of manipulative skill would doubtless be sufficient. But if they are to find a living, a good proportion of them must go into new countries, where they will have to make the few tools of a millwright's shop compass the entire range of work which here requires a large establishment. If they are to be successful, they must have considerable personal skill to supplement the deficiencies of their tools, and a ready aptitude in scheming appliances and methods of working to meet special cases. To combine the training necessary for a colonial engineer with the wide theoretical knowledge and the general educational attainments which are everywhere demanded in the present day will be, for most men, difficult, and for not a few impossible. If a man could map out his career at the commencement, he might then cultivate that branch of knowledge in which he was to be engaged, to the exclusion of the rest. But it is given to few to see the track they shall pursue stretching out clearly before them, and most must prepare themselves, as far as their capabilities will permit, to take any line which opens.

There is, however, one form of mechanical work which may be followed at any time, and which gives great manipulative power without destroying the freedom of the hand or obliterating the taste. Such an occupation is to be found in ornamental turning, which offers the most valuable adjunct to the education of an engineer. It necessitates the most conscientious care and patience and the exercise of forethought, neatness, and accuracy. At the same time, it gives endless scope in the designing of patterns and in the selection of the most appropriate methods and tools for producing them. Handicraft skill, moral training, and artistic cultivation are alike acquired by the practice of ornamental turning, which, from an educational, as distinguished from a business, point of view, has many advantages possessed by no other mechanical pursuit, and which forms the hobby and engrossing relaxation of many whose period of active education has long since passed. In demonstration of the fact that turning may be followed without loss of mental or artistic freedom, we will give a short account of a few of the leading appliances used and of the work that can be produced in the amateur's lathe. The art of ornamental turning is one that is comparatively unknown to the engineer. He studiously avoids all complicated forms in his designs, particularly in those parts which cannot be produced by casting, and consequently his tools and his experience scarcely go beyond the production of plane surfaces and solids of rotation. Engine turning, eccentric turning, rose cutting, and the like are little more than names to him, and he regards them as processes with which he has nothing to do.

The amateur's lathe is, of course, identical in principle with that used by the engineer, but is distinguished by the large number of auxiliary appliances by which it can be adapted, not only for producing solids of rotation, but also for planing, grooving, drilling, and milling. Further, as nearly all ornament consists in the repetition of some typical form, the lathe is provided with special means by which motions of the same extent and character can be repeated again and again with absolute accuracy. In the slide rest, in its more complete form (Fig. 1), the screw is made of ten threads to the inch, and is provided with a micrometer gauge, dividing one revolution into 20 parts, for measuring distances traversed by the tool to the 200th of an inch. By counting the turns and divisions, a cut of a given length can be produced exactly without further measurement. When the same traverse has to be often repeated, the labor of counting is saved by the use of fluting stops, as shown, which are clamped on to the slide, and limit the travel of the tool holder. The slide itself is carried in a cradle, and can instantly be swiveled into a position parallel or perpendicular to the mandrel of the lathe, or by the quadrant attached to the rest, to any angle between. The tool slide is likewise provided with adjustable screw stops, and a lever by which it is fed up and arrested. For turning curved forms, there are used templates bolted to a rail on the slide. A feeler on the tool holder runs in contact with the template as the screw is turned, and moves the tool in and out in the required manner.

Fig. 1.

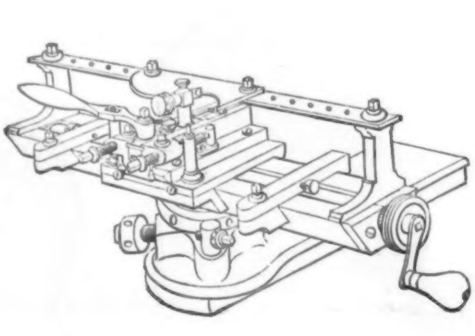
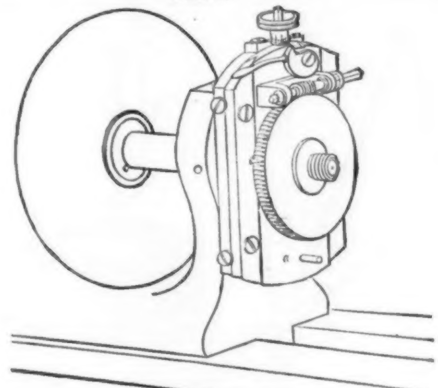


Fig. 2.



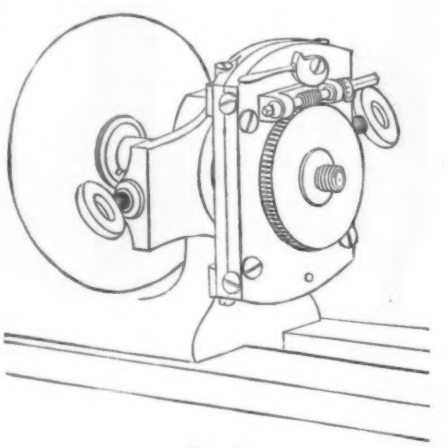


Fig. 3.

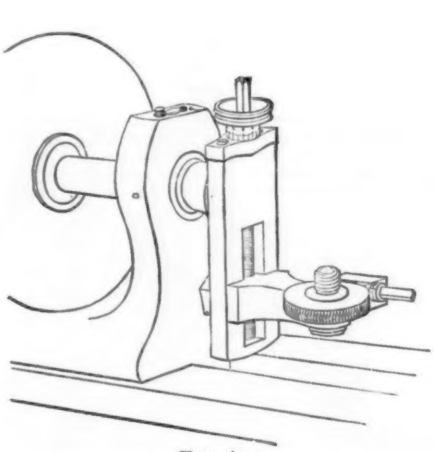


Fig. 4.

EDUCATION IN HANDICRAFT.

The headstock carries on the mandrel a dividing plate, provided with several rings of divisions, so that almost any angular movement can be obtained. Added to this, it is furnished with a wormwheel of 180 teeth, turned by a screw of definite pitch, which latter is provided with micrometer gauges variously graduated.

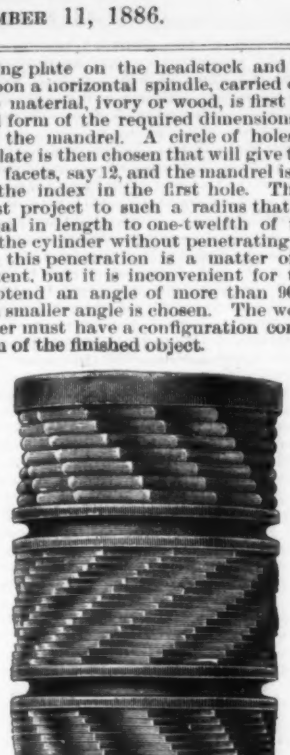
But the peculiarity of the amateur lathe lies in its chucks, and it is these that form the essence of its difference from ordinary lathes. The first is the eccentric chuck. This (Fig. 2) is an exceedingly simple appliance, but serves a great many uses. It consists of two plates, sliding the one over the other. The rear plate is tapped to screw on to the nose of the lathe mandrel, and the front plate carries a screw exactly similar to that on the mandrel. The relative positions of the two plates can be varied by means of a main screw, of ten threads to the inch, provided with a micrometer head with twenty divisions, that is, in agreement with the main screw of the slide rest. By this screw the chuck can be placed at any desired distance, within its maximum range, eccentric to the mandrel, and then, by means of the wormwheel and tangent screw, every point in the work having that amount of eccentricity can be successively centered. The wormwheel has ninety-six teeth, and can be rotated either by the screw or by hand, the screw frame being pivoted to the slide. Among the uses of a chuck such as this are the production of all kinds of surface patterns, consisting of circles or parts of circles arranged around a central point, and the formation of solids of rotation in which the different parts have not a common axis. To take a familiar example, it would be possible, upon an eccentric chuck, to turn up an eccentric, and bore the hole in it, without removing the block from the face plate, or a crank might be bored and the crank-pin turned in the same way.

The next of the series is the oval or elliptical chuck (Fig. 3). In this the plate which carries the wormwheel and the screw slides backward and forward horizontally at each revolution, the amount of its motion determining the difference between the two axes of the chuck. A ring or cam, fixed on a sliding frame, is mounted upon the face of the headstock by means of two pointed thumbscrews, which enter into countersunk holes at each side. By tightening one screw and slackening the other, the cam can be moved horizontally to carry the ring into a position more or less eccentric as regards the mandrel, the amount of such motion being shown by a scale and pointer. The chuck itself is formed of two plates, the one sliding on the other. The back plate is screwed to the mandrel, and has on its rear face two straight pallets or guide pieces, which are attached to the front plate. These pieces behind the back plate bear on each side of the cam, and carry the front plate backward and forward, according to the eccentricity of the cam. This chuck, like the preceding, is furnished with a wormwheel and screw for setting the work. Among its uses, the most prominent is the production of articles like oval picture frames and other oval solids, and after this comes the formation of surface patterns, consisting of ellipses of various sizes, and arranged so as to give peculiar effects by their intersections. It must be remembered that in ornamental turning a great portion of the cutting is done by revolving tools upon a stationary object, and thus an elliptical body may be covered with surface decoration formed of other ovals, circles, or parts of circles, the chuck merely coming into action as the mandrel is turned through small distances by means of the dividing plate for their various dispositions.

The spherical or dome chuck is so clearly shown in Fig. 4 that it scarcely needs any description. The main screw is ten threads to the inch, and the wormwheel has 96 teeth. It must be understood that this chuck is never required to revolve at speed. On the contrary, it remains stationary, as shown in the figure, during the construction and decoration of many polygonal forms, and for the majority of other services it either makes a slow continuous partial rotation between limits determined by the division plate or a partial or complete interrupted rotation arrested from point to point by the division plate, or tangent screw movement of the lathe head, for the tool to make its distinct incisions. Its great use is in the production of numerous very complex solids, and for the more simple ornamented hemispheres or domes, a very favorite form in this class of turning, where they form the lower portions of vases, the basins of urns, and the like. The rectilinear chuck is another that is intended to be stationary, or only to make a partial rotation between stops. It closely resembles the eccentric chuck (Fig. 2), only differing from it in the extra solidity of its construction and in the fact that the sliding plate can be moved to either side of the mandrel center, instead of to one only. Its use is to hold work that is being acted upon by drills or revolving cutters, and to carry other chucks, such as the spherical chuck, which are interposed between it and the work, the two chucks being used in combination for the production of more complex solids than can be produced by either alone.

The clearest idea of the uses to which these appliances are put will be gathered by the description of the manufacture of a few typical forms. At the same time, it will be seen how apparently complicated effects are obtained by the repeated use of simple patterns. On the opposite page are shown four types of ornament of the same general description, although very different in appearance. They are all produced by aid of

the dividing plate on the headstock and a cutter revolving upon a horizontal spindle, carried on the slide rest. The material, ivory or wood, is first turned to a cylindrical form of the required dimensions, in a plain chuck on the mandrel. A circle of holes upon the dividing plate is then chosen that will give the required number of facets, say 12, and the mandrel is secured by inserting the index in the first hole. The revolving cutter must project to such a radius that it will take a cut equal in length to one-twelfth of the circumference of the cylinder without penetrating too deeply. Of course, this penetration is a matter of taste to a certain extent, but it is inconvenient for the cutting arc to subtend an angle of more than 90 deg., and generally a smaller angle is chosen. The working edge of the cutter must have a configuration corresponding to the form of the finished object.



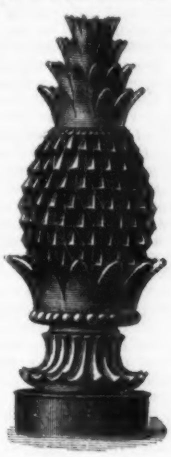
The cutter spindle is mounted in a bearing on the slide rest, and is driven by a cord from an overhead drum which receives its motion from the treadle shaft. The upper slide of the rest is then advanced until the cutter meets the stationary work and scoops a segment out of it. When the cut has advanced as far as is thought safe, the position of the slide is determined by one of the gauge screws (Fig. 1) being moved up to its stop. The cutter is then drawn back by the lever, and the lathe mandrel with the work is rotated one-twelfth of a revolution and again fastened. The cutter, never ceasing in its revolutions, is then run forward to the stop, and it is found, if due care has been exercised, that the two trial cuts fail to meet by a short distance, say $\frac{1}{16}$ in. This space is then readily bisected by equally deepening both the trial cuts, and the cut thus advanced to its right depth, the ultimate position is marked by the gauge or depth screw of the slide rest. After this each facet is cut in succession, the cutters being withdrawn and the mandrel being partly rotated as each is completed, until the whole circuit is made. Supposing the dividing circle to have 144 holes, the first ring of facets will be made on the holes 0, 12, 24, 36, and so on. The second row is advanced by $\frac{1}{72}$ part of a revolution, and, therefore, is cut on the holes 2, 14, 26, 38, and so on. The third ring begins on hole No. 4, the fourth on No. 6, and so on for different groupings. The cutter is transferred from one row of facets to the next by the main screw of the slide rest, and is adjusted either by eye or by turning the screw through a certain number of degrees equal to the width of the cutting edge of the tool. All the parts of the apparatus are so exact that the latter method may be relied upon with certainty if reasonable care be taken to avoid back lash.

The second pattern requires no explanation; it is cut with a flat ended tool, in the same manner as the preceding example, except that the rows are stopped in the opposite direction. The adjoining pattern shows a case in which the rows are first stopped in one direction and then in the other. In the remaining pattern there is an attempt at a spiral or scroll. Each row of facets stands with its points opposite the hollows of the adjacent rows, and the result is a basket work effect, more or less coarse, as the cutting is deeper or shallower.

Leaving these simple forms, we will take another which makes greater demands upon the skill of the workman. The stopper shown in the next column is made in three parts, the pineapple-shaped body being separate from the ends. The base is, of course, turned to shape in a chuck, and then it is fluted, beaded, and cut into a crown. The fluting may be done in various ways. One would be to place the work in a chuck on the nose of the mandrel, and cut the flutes with a revolving cutter rotating on a vertical axis. This operation would be substantially similiar to that described above, except that the cutter would be in a horizontal, instead of a vertical, plane. Another method would be to mount the work on the spherical chuck, and place this again on the eccentric chuck. The former would then be adjusted vertically and the latter horizontally until the point to which the fluting is central coincided with the center of the mandrel. A rotating round-nosed drill mounted on the slide rest would then be fed forward until it entered the material to the required depth, after which the mandrel would be rocked by hand through about 120 deg. to extend the hole into a long curved flute. When one cut was complete, the work would be rotated by the worm and wormwheel on the spherical chuck and a second cut, and so on.

The row of hemispherical beads is likewise produced with a drill having a recessed end, which leaves a button at the bottom of the hole. The work may be either held in a plain chuck and rotated the required proportion of a circle by aid of the dividing plate, or it may be fixed on the spherical chuck and rotated by the wormwheel. The crown is cut by a rotating cutter. If the work is in a plain chuck, the cutter will be on a vertical axis; if it is in the spherical chuck, the axis may be horizontal or vertical, according to the position in which the chuck may be for the time held on the mandrel by the division plate and index. The capital of the stopper is produced in substantially the same way; the blank is first turned, and then the rings are divided into petals by a revolving cutter of such a form that it removes the entire material between two petals at one operation.

The central or pineapple-shaped body introduces another arrangement, the spiral apparatus. The ama-



teur's lathe has no guide screw, and spirals have to be cut by aid of the screw of the slide rest (Fig. 1), which is geared to the back or front of the mandrel by a train of wheels, mounted on a pivoted arm such as in the engineer's slide lathe. The screw is turned by hand by its winch handle, and is made to drive the mandrel for all spirals which are above ten threads to the inch in coarseness. The material is removed by a revolving cutter, either a drill or a fly-cutter mounted upon the upper slide of the rest. When the general form of the object is cylindrical, the upper slide is merely carried backward and forward parallel to the lathe bed; but in the case before us, it must also advance and recede at the same time. This motion is obtained by the use of curved templates (Fig. 1), which permit the slide to move inward, or force it backward as the point or feeler traverses their acting surfaces. For the work before us a fly-cutter, with its axis perpendicular to the spirals, would be more suitable than a drill, as a certain amount of distortion would be produced toward the ends of the body, by the drill not standing at right angles to the work.

This stopper does not offer any example of eccentric turning, but, with a little alteration, it might be made to do so. Suppose the capital were replaced by a single crown, each member of which was surmounted by a ball, somewhat after the manner of an earl's coronet. Then by mounting the whole on the eccentric chuck, and centering each ball successively, the balls could be turned up just as if they were being manufactured independently of the general object. Again, if the eccentric chuck were superposed on the oval one, ornaments of elliptical cross section might be produced.

It is not, however, our intention to write a handbook to the lathe. We have not mentioned one-quarter even of the more common appliances; and those who wish to pursue the subject further, we refer to the exhaustive volumes published by Mr. Holtzapffel, of Charing Cross, London. Our object has been to show that it is possible to provide an educational course in the use of tools that shall not stunt the abilities of those who pursue it, but which, while conferring skill in handicraft, will at the same time cultivate the artistic faculty, exercise the invention, and stimulate the intellectual powers to wander afield in search of beauty and novelty, instead of walking in a narrow path bounded by straight lines. By slow degrees the work of engineers is losing the horrid angularity of outline it once possessed, but the progress toward beauty is very slow, and the lapses are many and serious. The old idea that every youth who aspires to design machinery must first learn to file exactly flat, or to chase a thread the sobriety of which is beyond all reproach, is dying out, and the time-honored thorough apprenticeship is giving way to a hasty passage through the shops in which nothing is learned properly. If such a training be supplemented or preceded by leisure hours filled with work which demands patient care, labored exactitude, and fertility of resource, and at the same time produces beautiful forms and highly ornamental surfaces, many a circumstance that would pass unnoted in the fitting or erecting shop will be appreciated and turned to good account.

THE ELECTRICAL TRANSMISSION OF ENERGY.

WHILE M. Marcel Deprez has been occupied in carrying out his important series of experiments on the electrical transmission of power between Creil and Paris, of which we have from time to time published particulars, M. H. Fontaine, who, at the Vienna Exhibition of 1873, made the first public demonstration of this nature, addressed himself to the task of realizing in a simple and inexpensive manner, a means of electrical transmission which should fulfill the conditions of the imposing programme prepared by his scientific competitor. He first cut out one of the costly elements of the installation, by placing the generating and receiving dynamos in the same building, and by substituting for the line connecting the station at Creil with that at La Chapelle a resistance equal to 100 ohms. Of course, the objection may be fairly made that an experiment which is to serve as the basis of practical applications must be carried out as closely as possible under actual conditions, with a working line which would introduce all the difficulties and contingencies of practice. But on the other hand, this strict approximation to reality is purchased very dearly, and the information it affords is scarcely worth the cost of 112 kilometers of heavy cable and special posts required for the Creil experiments. When it is possible to obtain at a nominal cost the equivalent of this line, with the additional advantage of being able to follow each phase of the experiment at both ends at the same time, without any of the complications inseparable from widely separated stations, there can be little question as to the advantage of M. Fontaine's method.

The experiments were carried out at the works of the Compagnie Electrique, and no new apparatus was introduced during the trials. The dynamos employed were Gramme machines of the "Superieur" type, but in order to attain the enormous tensions employed by M. Deprez with his specially constructed dynamo, M. Fontaine placed four machines in series in such a way as to obtain a fall of potential of 6,000 volts. The current was about 10 amperes. The receiving machines were three in number of similar type, and also arranged in series, and the primary motor was a 100 horse power engine. Under these conditions an experiment was carried out by M. Mascart, with the following results, which were embodied in a paper submitted by him to the Academy of Sciences on the 20th of October last:

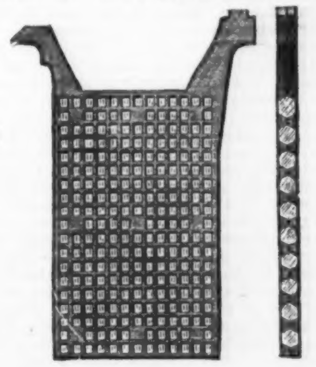
Speed of engine	56 rev. per min.
" generator	1298 " "
Difference of potential at the terminals of first dynamo	1490 volts.
Difference of potential at the terminals of second dynamo	1505 "
Difference of potential at the terminals of third dynamo	1493 "
Difference of potential at the terminals of fourth dynamo	1508 "
Difference of potential at the end of conductor	5996 "
Resistance of line	100 ohms.
Current	9·34 amperes.
Power of engine	112·8 horse power.
Useful energy of engine	85 per cent.
Energy imparted to generating dynamos and transmitted to receivers	95·88 horse power.
Speed of receiving dynamo	1129 revolutions.
Work delivered at the brake	49·98 horse power.
Efficiency	52 per cent.

If these results are compared with those embodied in the report of M. Maurice Levy upon the Creil experiments, it will be seen that the two experiments have been made under technical conditions practically similar. But the former are far superior as regards the economic phase of the problem. M. Levy estimates that the transmission of 50 horse power from Creil to Paris would require a generating dynamo costing 50,000 francs and a receiver costing 30,000 francs, besides the conductor. In the experiment of the Compagnie Electrique, the seven Gramme machines represented a total value of 16,450 francs and a total weight of 8,400 kilos., so that the transmission of 50 horse power through a resistance of 100 ohms involved, per horse power, the use of 167 kilos. of dynamo at a price of 2 francs per kilo.

These figures are interesting because they correspond with those under the best industrial conditions that have been realized up to the present time in the transmission of power through considerable distances. Moreover, it is evident that there would be a great advantage in using a uniform and commercial type of dynamo grouped to any desired extent, instead of building special machines for every separate nature of installation. Whatever may be their practical value, it is clear that these experiments of M. Fontaine mark a distinct progress toward the solution of the interesting problem of the transmission of power by electricity.—*Engineering.*

GADOT'S ACCUMULATOR.

WE illustrate a new accumulator plate, manufactured by M. Paul Gadot, of Paris. The object which the inventor had in view was to prevent the falling out of



the peroxide of lead plugs, which sometimes takes place with the usual form of grid. As is well known, the plugs in the usual plate have the form of a double truncated pyramid, the center portion, which is in the middle of the plate, being of least area. If the plug parts in this place, there is nothing to hold the two halves in. Now, in the improved grid which we illustrate, the center portion of the plug is larger than either of the end surfaces, and, consequently, the plug cannot come out of the grid without being completely crushed. As it would be impossible to cast such a grid in a solid mould, M. Gadot makes the grid in halves, and places these halves together, with the small end of the holes to the outside, thus obtaining square cavities of the desired form. A few of the squares are kept solid in order to join the plates in different points. It is evident that, with a grid so constructed, the total weight of lead must be somewhat larger than in the usual plates, or, in other words, there is more solid

lead in comparison to the active material. But this is not a very serious fault for stationary work, and if we may judge by the table of sizes and weights published by M. Gadot, the increase in weight, as compared with other types of plates, is not excessive. The total weight of complete cells varies between 3 cwt. per h.p. hour for the smallest size to about 1½ cwt. per h.p. hour for the largest size, the latter having an output of a little under one h.p. hour. For the purpose of comparison, we may mention that the E.P.S. accumulator used in the Volta weighs about 1 cwt. per h.p. hour of output, and from experiments made by M. Eric Gerard with the Julien accumulator at the University of Liege, and published in his recent book, we find that the latter accumulator has an output of a little over one h.p. hour per cwt.

PROGRESS OF ELECTRIC MOTORS.*

By T. C. ROBBINS, of Baltimore.

MR. PRESIDENT AND GENTLEMEN: Your committee on the progress of electricity as a motive power respectfully report as follows:

In searching for the first experimenter in the field of electric locomotion, it very soon becomes apparent that extreme difficulty will be experienced, due to the great number of visionary experimenters which seem to be attracted to this branch of physics. Though the experiment of Jacobi on the river Neva in 1834 certainly demonstrated the possibility of producing a not inconsiderable force by electrical means, a casual inquiry as to the cost of the experiment conclusively proves that very little hope remained of its application assuming a commercial form so long as chemical decomposition was the only recognized means of exciting electricity.

It remained, however, for later scientific investigators to point out that this was not due so much to the inefficiency of the producer as the exceeding crudity of the receiving apparatus and the necessary high cost of the electric fuel, so to speak, which in this case, as in many subsequent cases, was zinc. In view of the really discouraging character of this experiment regarded as even a possible commercial achievement, it is surprising that many inventors could have been found sufficiently bold to make any other attempts until radical changes had been made in the producing force; but history records that a number of other daring experimenters attempted to supplant the steam locomotive within the next decade. It is not, however, recorded that a sufficiently hopeful result was obtained at this period to be regarded as anything more than an interesting scientific display.

The intervening experiments were hardly worthy of record until the year 1860, when Prof. Page made the first recorded experiment of any note, with batteries having carbon plates in place of the inferior copper ones formerly employed. It is recorded that by means of his improved apparatus, Prof. Page was enabled to drive a car load of passengers through the streets of Washington with an electric locomotive, traveling at the rate of 20 miles an hour. Though it is quite possible the speed is here exaggerated, and that the car load of passengers was propelled only on the level, which would not necessarily call for a powerful effort, it is still noticeable that such an achievement was possible simply by the use of batteries and the imperfect apparatus of that time, in a manner sufficiently satisfactory to have attracted a number of business men, who for some time anticipated great results. It is now evident that nothing of a commercial nature could possibly have followed with the means at command; and though a number of more or less successful experiments of a similar kind were made, nothing of sufficient importance to even promise a commercial result occurred until the year 1879, when Messrs. Siemens & Halske, of Berlin, operated a small electric railroad of about one-third of a mile in length at the Berlin exhibition, employing an auxiliary conductor between the rails, from which the current was taken up by means of a metal brush and transferred to the motor in the now well known manner. Several more of these small locomotives, being rated at one or two horse power, were made during the years 1879 and 1880, and it is recorded that with this apparatus the current was sufficiently powerful to throw horses when accidentally placed in contact with the third rail. These latter experiments partook of a much closer approximation to the commercial character, for the simple reason that during the interval between Prof. Page's test and that of Messrs. Siemens & Halske the greatest advance yet recorded in electric locomotives had taken place, namely, the introduction of the mechanical producer or dynamo machine, which apart from the details involved rendered possible the substitution of coal for zinc as a fuel. That the energy of the former had now to be passed through a steam engine was a comparatively important detail, considering the enormous disproportion between the energy produced from coal and zinc, from a financial standpoint; and though the inefficiency of the engine as a thermo-dynamic motor militated strongly against the complete triumph of this new order of things, the extraordinary efficiency of the infant dynamo operated in great measure to place the new power on a commercial basis. Indeed, so wonderfully efficient were even the earlier dynamos manufactured by Messrs. Siemens that the first recorded results proved indisputably that under such favorable conditions as those which Messrs. Siemens were able to avail themselves of, competition with horse flesh seemed possible even from the first, though it was a daring man who in these times would even hint at competition with steam and other well known converters.

The little machines above noted were so satisfactory in their operation that they were quickly followed by an electric railway for actual business traffic, which was constructed by Messrs. Siemens & Halske between Lichterfelde and Military College, Berlin. The electric motor or car on this road was built so as to closely resemble the ordinary European tram car, and the motor was attached under the floor. It is recorded that the performance of this car was eminently satisfactory in dry weather, but considerable difficulty was experienced in operating in wet weather, until several changes had been made in the manner of conducting the current, it being subsequently found necessary to use an overhead conductor, which is the first recorded example of this kind, and appeared to be so successful that the road has continued running without any radical changes up to this time. It must, however, be remembered that the power required was very small, since the road is entirely level from end to end, and the car was limited in size, being only able to carry about twenty-five persons when fully loaded.

Passing over a number of minor experiments which followed this achievement of Siemens on the other side, the first notable example after that of Prof. Page's in this country appears to be the electric locomotive of Thomas A. Edison in the summer of 18:2, which is said to have attained a speed of nearly 40 miles per hour on a level track, at Menlo Park, New Jersey. The experiments were conducted for a considerable time, but do not appear to have been of a character sufficiently encouraging to warrant any attempt in a commercial way, and no machines of this type were ever placed on a commercial road. The manner of taking up the current was similar to what had before been tested by Siemens in Berlin, and afterward abandoned as not affording sufficient insulation in wet weather.

Later in the year 1882, Leo Daft constructed a number of small electric locomotives, which were tested and run for a considerable time on a track provided at the works of the Daft Electric Light Company at Greenville, New Jersey, which were the first recorded example of a number of locomotives (there were four employed at one time) running on the same track at the same time, from the same generating apparatus; and a number of experiments were conducted from time to time for the satisfaction of a large number of visitors, among whom were many electrical and engineering experts, to prove what was then a matter of considerable doubt, that locomotives could be run in parallel from a producer of sufficient capacity. This was so completely demonstrated at that time that in this direction no further doubts existed, though it seemed to be for a long time the standing objection to the progress of this new enterprise from those who were less familiar with the true inwardness of this problem. On these occasions the four cars were purposely manipulated in the most difficult manner, being all started at the same time as nearly as possible, and all the evolutions which a most exacting audience demanded were made without at any time showing the least reason to doubt that the system was capable of indefinite extension on the same lines. Not the least extraordinary of the effects which constant experiments developed was the remarkable tractive capacity of the motors when operated with insulated wheels and using both rails as the conducting system. It was clearly shown that a small locomotive weighing but 450 lb. was capable of developing the extraordinary tractive force of 300 lb. on a dry rail. This was repeatedly demonstrated, and the subsequent experiments with the same apparatus developed the astonishing fact that it was capable of ascending a gradient of 2,900 ft. per mile without any extra tractive appliances whatever, and with a driver weighing upward of 150 lb. to add on the car. It will thus be seen that an effect was arrived at contrary to anything which may be evolved from the coefficients of Molesworth. There have been many opinions as to the cause of this, but the fact remains that the above achievement was repeated day after day before a large number of technical persons, and can of course be repeated at any time, though it is not possible to reproduce this effect on the large scale required by commercial practice, for reasons which cannot form a part of this paper. The increased traction under favorable conditions is not by any means an unimportant feature in considering the relative weight and energy of a given motor. In the fall of 1882, an experiment was made at Chicago national exhibition of railway appliances with a motor consisting of a Weston machine placed upon a platform car and driven by a second Weston machine, by means of two copper conductors placed near the track. This car traveled on a circular track under cover without any gradients, and, as might have been expected, created a favorable impression among the spectators, though it would not be classed with commercial performances, since the energy required was comparatively insignificant; it served, however, to keep up the public interest in matters of that kind, and was so far successful.

In February of the following year, it is recorded that a motor weighing 300 lb., constructed by Chas. J. Van Depoele, was put in operation at the works of their company, and operated a car which is stated to have been capable of carrying 25 people, and the trials were conducted for several days, and are said to have met with perfect success. In the following year a number of experiments were carried out at the Daft Company's factory at Greenville, New Jersey, with a view to demonstrate the possibility of electric locomotion on a much larger scale; and in May, 1883, an electric locomotive, afterward called Ampere, was begun for an experiment on the Saratoga and Mt. McGregor Railroad, a narrow gauge road running from Saratoga about ten miles to Mt. McGregor. Some time was occupied in experiment prior to the construction of this machine, but in the fall of the same year (1883), the locomotive was finally finished and forwarded to Saratoga, where a number of experiments were made on a part of the track which had been furnished with a third rail to the distance of about a mile and a quarter from the depot, the dynamo machines being situated about midway and a few hundred feet from the track. In this case a third rail was used, supported on blocks of wood saturated with resin, and experiments revealed the fact that with the low potential employed, the insulation was sufficient for a practical experiment, even when a considerable portion of the tracks was covered with snow. The main achievement of this was that it towed a car weighing over 10 tons, loaded with 68 passengers, over the road, including a gradient of 93 ft. per mile. Though several difficulties were here experienced, due to the comparative crudeness and temporary character of the local arrangements, sufficient was accomplished to prove the possibility of commercial electric traction; and since it was the first example of electric locomotion on an ordinary steam railroad, it attracted attention, and encouraged others to proceed in the same direction. It is noticeable that about this time a number of experiments were recorded with what are now known as accumulators on the other side of the water, and a number of more or less successful experiments were made, which only served to develop the fact that accumulators were then, as they are probably now, susceptible of great improvement.

The extraordinary impetus which had been given by the introduction of the dynamo machine was re-enforced by the comparative success of the experiment just noticed, so that within the next few months a large number of electricians and others found themselves sufficiently encouraged to construct a great variety of electric apparatus for the complete extinction of horses and steam. As you are doubtless aware, the greater part of these have been entirely unproductive; but the most notable cases have not only survived, but are now being prosecuted with a vigor and success which naturally results from their having assumed a thoroughly commercial character; and in the year 1884 a combination of important capitalists was effected under the title of the American Electric Railway Co., with a view to placing everything of this kind on a sufficiently strong commercial basis to insure its adoption, but as some difficulty was experienced in securing concerted action, nothing of importance has yet resulted from this combination, the inventors, as before, pursuing their different ways alone. Here, perhaps, it may be as well to state that electric locomotion alone had not by any means absorbed the attention of inventors, the question of transmission of power for stationary purposes having appeared to present an even more attractive field. Much had been accomplished in this direction, and practical results attained by such distinguished inventors as M. Marcel Deprez, Messrs. Siemens & Halske, of Germany, and Sir William Siemens, of England, together with Messrs. Ayrton & Perry, and others of lesser note. Notable among the achievements of the French inventor was the transfer of nearly forty horse power for a distance of several miles by an ordinary telegraph wire.

In this country, though workers in this direction have apparently been less numerous, the results have generally assumed a more important character regarded as a commercial achievement. The first recorded example of the establishment of a central station exclusively for the distribution of power was that of the Massachusetts Electric Power Company, which was placed in May, 1884, and has since grown to considerable proportions. This company uses the Daft system. Several others similarly equipped have since been put in operation with entirely satisfactory results, which my paper will not allow me to describe. There are, however, a large number of satisfactory motors in operation in different parts of the country, though not, so far as I know, worked from stations exclusively for power; among the motors so employed may be mentioned the Sprague, Van Depoele, Edgerton, Baxter, D'hul, and a host of others, which may fairly be said to be too numerous to be mentioned, though with one or two exceptions these inventors have devoted themselves to matters of very small power, especially for use in operating sewing machines, dental instruments, etc.

In August, 1885, Messrs. Knight & Bentley operated a small road in the city of Cleveland, O., with a subterranean conductor, which may be said to be the first serious attempt with that form of conduit yet made in this country. The experiment extended over a considerable period, and is described as being quite successful, though for some reason of which I am not informed the plan was not adopted, and the experiments have been discontinued, though these gentlemen are still doing good work in Providence, R. I., and are, I trust, preparing themselves for a brilliant future. It will be unnecessary for me to remind you that a plan of this kind must ultimately be adopted in many of our large cities, particularly since the beginning of the overhead-wire crusade.

In the year 1885, C. J. Van Depoele constructed and operated a locomotive which is said to have done excellent work at the Toronto exhibition, in the fall of last year, and this has been followed up from time to time by notable work and experiments in different parts of the country, chiefly among which may be mentioned Montgomery, Ala., South Bend, Ind. This inventor, after the manner of the early German road, has adopted an overhead conductor, which seems specially suited for use in cities where the necessary permits can be obtained, and appears to have met with such success as to promise greater things in the future.

Passing over some minor achievements, I am led to speak of the installation of the Baltimore and Hampden Electric Railroad as the one commercial plant which has been operated for a sufficient time to allow of a proper statistical comparison, not only with horses, but with other mechanical tractors, and in so doing I append figures showing results of operating this road for twelve months by the Daft system, including a winter of extraordinary severity for that region, and under such conditions as I am sure you will conceive are sufficiently commercial in their character. A profile of the gradients and curves on this road will be a sufficient assurance that the experimental element has not been allowed to predominate in selecting the ground for such purpose, except in a manner sufficiently prejudicial to afford unusually severe means for satisfying ourselves as to its enduring character. The statistics here appended will afford so clear an insight into the results of this experience that I will not further dwell upon it, except to remark that, though I must confess myself strongly in favor of so convenient and sufficient a substitute for horses, or other mechanical tractor so far tested, I have not allowed myself to be led astray by the scientific allurements of the case, and feel satisfied that a careful analysis of the case will lead others to conclude, as I do, that electricity employed as the means of transferring the energy of mechanical tractors is not only coming, but is here, and in all essential particulars has been here for some time past. It is not too much to add that the Baltimore and Hampden Road stands alone in this particular, that it was started on a purely commercial basis as a purely commercial transaction, and has continued, and is now being extended, simply because it has proved its right to stay by the performance, which leaves little to be desired in that direction.

About the time that the Baltimore road was started, the Daft Company was engaged upon the manufacture of a large electric motor, Ben Franklin, intended for use for experiment on the Ninth Avenue Elevated Railroad in New York. This was subsequently put in operation and experimentally used for a considerable time on a short track at Fourteenth Street, and towed four cars over two miles of that road. It was ascertained during these experiments that a more powerful motor would be required to fully meet the require-

* A paper lately read before American Street Railway Association.

ments of the case, and the experiments will shortly be resumed on a larger basis.

Lieutenant F. J. Sprague has since built and put in operation a motive car on a short branch of the Third Avenue Elevated Railroad at Thirty-fourth Street. The experiments with this motor have not yet been concluded, but I understand that they have been quite successful, and will probably result in an extended application of this motor.

In concluding this brief review of this comprehensive subject, I feel that I should not be doing it full justice if I were not to attempt a refutation of many charges which have been brought against electricity by persons unfamiliar with its peculiarity.

It is said to be unsafe; and though with high potential this is undoubtedly the case, I am prepared to say that with the potential now in use on the Baltimore and Hampden Railway, the experience by a year's constant running 18 hours per diem leads me to state that so far as human life is concerned it is absolutely harmless.

Secondly: It has been said to be uncertain. Again, quoting the experience of a year, I am able to state that after the little difficulties incident to a primary installation had been removed during the first month or two, it is as certain as any other form of mechanical tractor in all weather.

Third: It has been stated that specially skilled help would be required to operate a line so equipped. I am again able to say that the experience before referred to has enabled me to place upon the road men who were entirely unfamiliar with electricity in any of its applications, and that these men are now our sole reliance for all the operations required, and interruptions are as much the exception with us now as with a y ordinary road.

For the year ending September 1, 1885, the road carried with three cars, with horses, 227,155 passengers at 5 cents each, making $11,357.75.

For the year ending September 1, 1886, the road carried with two cars, propelled by the Daft electric motor, 311,141 passengers at 5 cents each, making $15,557.05.

This shows an increase of 83,986 passengers with two cars propelled by electricity as against three cars propelled by horse power for the same corresponding time, and an increase of $4,199.30.

The average number of passengers carried per car per annum propelled by electric power was 155,570.

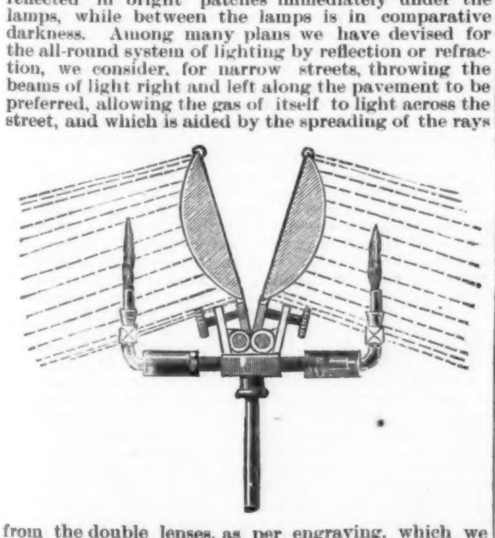
The average carried per car per annum for corresponding time by horse power was 75,718 passengers, an excess of passengers per annum in favor of electric power of 79,852.

The average gross earnings per car per annum, with cars propelled by electric power, was $7,778.52; the average gross earnings per car per annum by horse power was $3,785.91; showing an excess of gross earnings per car per annum in favor of electric power of $3,892.61.

The average cost of horse power per car per day is estimated at $6.50; the average cost of electric power per day on this road is 1½ tons of coal at $1.50, equals $2.25; engineer, $2.00; fireman, $1.50; oil and waste, 50 cents; interest on plant and repairs $2.75; making $9 per day. The power furnished at this cost is ample to run three motors and cars on this road, making electric power per car per day $4.00. Under more favorable conditions, such as cheaper fuel or water power to drive the dynamos, and more favorable gradients and curves, the cost of electric power per car per day would be proportionately reduced.

IMPROVED STREET LAMP.

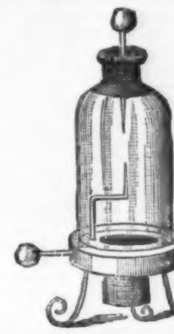
WRITING to the *Engineer*, Mr. John G. Winton says: "Not until each street lamp is turned into a miniature lighthouse, distributing the rays of light from the gas by reflection or refraction, can we say that gas has been fully utilized. We have many lamps burning a great quantity of gas, giving off a powerful light, and reflected in bright patches immediately under the lamps, while between the lamps is in comparative darkness. Among many plans we have devised for the all-round system of lighting by reflection or refraction, we consider, for narrow streets, throwing the beams of light right and left along the pavement to be preferred, allowing the gas of itself to light across the street, and which is aided by the spreading of the rays



from the double lenses, as per engraving, which we have practically tested in one of the lamps at the municipal buildings here, which we have been kindly granted the free use of by the authorities. There are two convex lenses placed close together at the bottom, with the convex surfaces inclined downward, and which can be set at any angle that may be determined on with the small set of screws as shown; likewise, the jets can be adjusted as shown, but this may be entirely dispensed with on ordinary occasions, the lenses and jets being quite rigid and immovable. The gas jets are placed in front of the lenses, and are always visible. The rays from the one are refracted through the convex surface, and, being caught up by the other lens, are refracted downward on the pavement at any angle that may be desired. It will thus be seen that the rays from the one light are refracted through the other light, and *vice versa*. With this plan there are no shadows, as with reflectors. A stream of soft light is thrown right and left along the pavement, and partially distributed across the street, and is by no means hurtful to the eye, while the gas of itself lights up the foot of the lamp and across the street. The gas remaining always visible is the main feature in this arrangement. We may mention that the lenses are four inches in diameter, but would recommend six inch lenses as preferable."

ELECTRICAL SMOKE CONDENSER.

THE accompanying illustration shows a convenient piece of apparatus by King, Mendham & Company, of the Western Electrical Works, Bristol, Eng., by means of which the interesting phenomenon of the disposition of dust and smoke by electric action may readily be produced and observed. It consists of a Bell jar, through the top of which is fixed a brass rod carrying a brass ball at its upper extremity and terminating in a point within the jar. Opposite to this is placed another rod, which passes out through the base of the



apparatus. Each of these rods is intended to be placed in metallic connection with an electrode of a Wimshurst electrical machine. The Bell jar is mounted on three supports, and beneath the base is a cylindrical box in metal, in which the fume can be produced. Smouldering brown paper is placed in this metal box, and when the smoke has completely filled the jar, the machine is started, and the smoke, which at first appears to be greatly agitated, is observed to be quietly vanishing, leaving the jar perfectly empty.

ELECTRIC COMMUNICATION WITHOUT WIRES.

By Prof. A. E. DOLBEAR.

THIS mode of electric communication has much scientific interest.

The following explanation of the drawing is from the specifications of the patent:

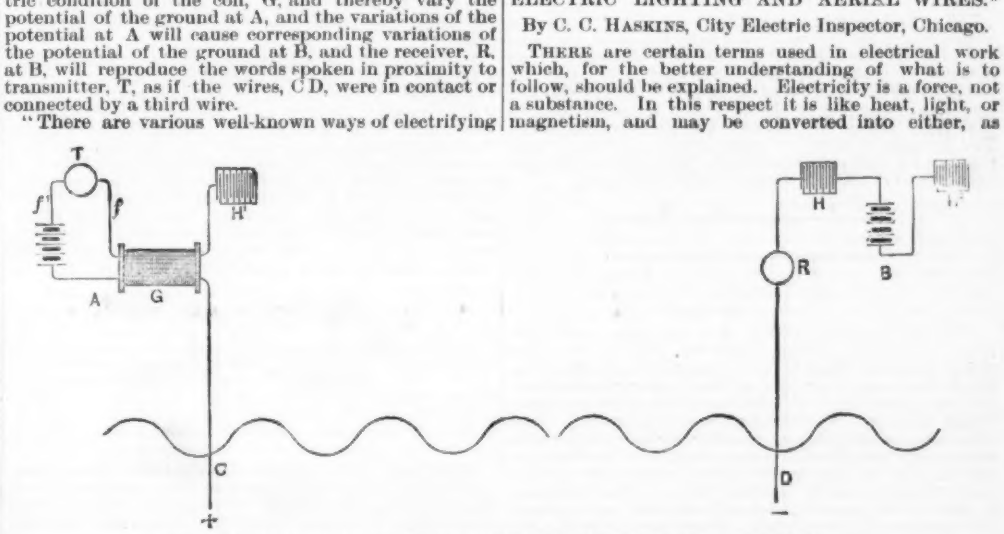
"In the diagram, A represents one place (say Tuft's College) and B a distant place (say my residence).

"C is a wire leading into the ground at A, and D a wire leading into the ground at B.

"G is a secondary coil, one convolution of which is cut, the ends thus formed being connected with the poles of the battery, *f*, which has a number of cells sufficient to establish in the wire, C, which is connected with one terminal of the secondary coil, G, an electromotive force of, say, 100 volts. G in this instance also represents an induction coil, T being a microphone transmitter, *f* its primary circuit, and *f*′ its battery—that is, the battery, *f*′, not only furnishes the current for the primary circuit, but also charges or electrifies the secondary coil, G, and its terminals, C and H′.

"Now, if words be spoken in proximity to transmitter, T, the vibration of its diaphragm will disturb the electric condition of the coil, G, and thereby vary the potential of the ground at A, and the variations of the potential at A will cause corresponding variations of the potential of the ground at B, and the receiver, R, at B, will reproduce the words spoken in proximity to transmitter, T, as if the wires, C D, were in contact or connected by a third wire.

"There are various well-known ways of electrifying



ELECTRIC COMMUNICATION WITHOUT WIRES.

the wire, C, to a positive potential far in excess of 100 volts, and the wire, D, to a negative potential far in excess of 100 volts.

"In the diagram, H H′ H² represent condensers, the condenser, H′, being properly charged to give the desired effect. The condensers, H and H², are not essential, but are of some benefit; nor is the condenser, H′, essential when the secondary, G, is otherwise charged. I prefer to charge all these condensers, as it is of prime importance to keep the grounds of wires, C and D, oppositely electrified, and while, as is obvious, this may be done by either the batteries or the condensers, I prefer to use both."

The principle is set forth in the claim of the patent as follows: "The art, above described, of communicating by electricity, consisting in first establishing a positive potential at one ground and a negative at another; secondly, varying the potential at one ground by means of transmitting apparatus, whereby the potential of the other ground is varied; and, lastly, operating receiving apparatus by the potential so varied, all substantially as described." Prof. Dolbear states that communication by this method is practical to a distance of half a mile at least. Its possible range has not yet been determined.

Prof. Dolbear described the method of electric communication under notice, at the Montreal meeting of the American Association for the Advancement of Science, in 1883.

We are indebted to him for some notes on the subject not specially prepared for publication, but of much interest, and from which we are pleased to print the following:

As to the experimental work: My first results were obtained with a large magneto-electric machine with one terminal ground through a Morse key, the other terminal out in free air and only a foot or two long; the receiver having one terminal grounded, the other held in the hand while the body was insulated, the distance between grounds being about 60 feet. Afterward much louder and better effects were obtained by using an induction coil having an automatic break and with a Morse key in the primary circuit, one terminal of the secondary grounded, the other in free air or in a condenser of considerable capacity, the latter having an air discharge of fine points at its opposite terminal. At times I have employed a gilt kite carrying a fine wire from the secondary coil. The discharges then are apparently nearly as strong as if there was an ordinary circuit.

The idea is to cause a series of electrical discharges into the earth at a given place without discharging into the earth the other terminal of the battery or induction coil—a feat which I have been told so many, many times was impossible, but which certainly can be done. An induction coil isn't amenable to Ohm's law always! Suppose that at one place there be apparatus for discharging the *positive* pole of the induction coil into the ground, say 100 times per second, then the ground will be raised to a certain potential 100 times per second. At another point let a similar apparatus discharge the *negative* pole 100 times per second; then between these two places there will be a greater difference of potential than in other directions, and a series of earth currents, 100 per second, will flow from the one to the other. Any sensitive electrical device, a galvanometer or telephone, will be disturbed at the latter station by these currents, and any intermittence of them as can be brought about by a Morse key, in the first place, will be seen or heard in the second place. The stronger the discharge that can be thus produced, the stronger will the earth currents be of course, and an insulated tin roof is an excellent terminal for such a purpose. I have generally used my static telephone receiver in my experiments, though the magneto will answer.

I am still at work upon this method of communication, to perfect it. I shall soon know better its limits on both land and water than I do now. It is adapted to telegraphing between vessels at sea.

Some very interesting results were obtained when the static receiver with one terminal was employed. A person standing upon the ground at a distance from the discharging point could hear nothing; but very little standing upon ordinary stones, as granite blocks or steps; but standing on asphalt concrete, the sounds were loud enough to hear with the telephone at some distance from the ear. By grounding the one terminal of the induction coil to the gas or water pipes, leaving the other end free, telegraph signals can be heard in any part of a big building and its neighborhood without *any connection whatever* to the conductor, provided the person be well insulated.

ELECTRIC LIGHTING AND AERIAL WIRES.*

By C. C. HASKINS, City Electric Inspector, Chicago.

THERE are certain terms used in electrical work which, for the better understanding of what is to follow, should be explained. Electricity is a force, not a substance. In this respect it is like heat, light, or magnetism, and may be converted into either, as any one of these is convertible into any other. Certain metals conduct heat more readily than others. Those metals or substances which conduct or carry electricity more readily than others are said to be better conductors. Those which are the best conductors have the least resistance, and, *vice versa*, those which the most perfectly obstruct the current are those which have the highest resistance. When we find a material or substance which is a very positively bad conductor, we call it an insulator. Dry air, dry wood, glass, porcelain, resinous gums, etc., these are all insulators. The metals, copper and silver first, are good conductors, while iron, having nearly seven times the

* Address delivered at the seventeenth anniversary of the Fire Underwriters' Association of the Northwest, held in Chicago, Sept. 8 and 9, 1886.

resistance of either of these, would require to be seven times the size of a copper wire to offer the same carrying capacity to a current. If we overload either wire, that is, send more current through it than its capacity or size warrants, the flow is obstructed and a portion of the current is converted into heat. Heat, then, is a result of resistance in a conductor, and it is to resistance—to this conversion of electricity into heat and light by resistance—to the work of overcoming an obstruction, that we are indebted for the electric lights of to-day. There are two general divisions of electric lights, known to the trade and to the public as well as arc and incandescent. The first of these is named from its being the result of an electric arc, a flame of electricity.

This arc is caused by an obstruction which a space of dry air offers to the passage of a current. Its carrying capacity is so inferior that the resistance transforms the current into light and heat. Two carbons, one on either side the arc, are slowly consumed. The incandescent light, which, as its name indicates, is not a conflagration, but a white, glowing heat, is the result, as in the former case, of resistance. The little wire-like loop is carbon. The space which the globe incloses is nearly enough so to be called a vacuum; the air is virtually exhausted, and there being no air—no oxygen—there can be no combustion.

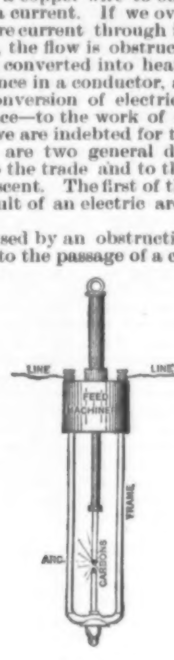


FIG. 1.

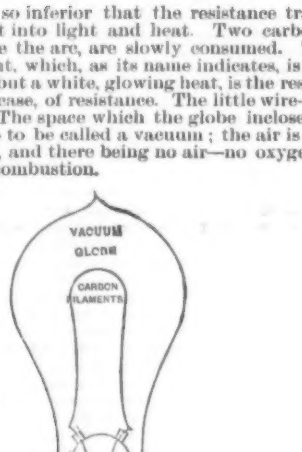


FIG. 2.

Let us first examine an arc light circuit. The means of producing the current is virtually the same for both this and the incandescent system—the dynamo. This dynamo, or generator, sends a current out to line; it comes to an obstruction at a lamp; it jumps the obstruction, passes on to the next, and so successively at each lamp, and arrives home much the worse for wear. The dynamo is, however, constantly supplying a current, and a waste—or conversion rather, for nothing in nature is ever wasted—is constantly made good.

FIG. 3.

Now, understand, this is the condition and performance of the current when the line is in proper order and form; that is, when the wire is perfectly insulated, separated by some of these poor conductors—air, glass, porcelain, etc.—from contact with anything which leads to the ground or some other line. The wire must be complete—a metallic path; from the generator out through all the lamps and back to the generator. It must be of sufficient size to carry the current used without sensibly heating through the resistance it offers to the current; that is, it must be large enough. If it gets hot, it is too small. Every portion of the line must be of sufficient capacity. Where the wire enters the lamp, where the ends of wire have been put together, at a joint, there must be full carrying capacity to prevent heating. Now, a line in which these conditions are fulfilled perfectly, that is, a line which is, *first*, thoroughly insulated from the earth and from possible contacts through which the current may escape, and get back to the generator by some cross cut or short road; and *second*, which has a wire of capacity sufficient to carry the necessary current without heating—such an electric light plant is thoroughly and perfectly safe while it remains in that condition.

To enumerate the multitude of faults which may occur in a line to render it dangerous would require much more time than the association would accord the subject. The two wires which run from the dynamo are often quite near each other for some distance, before they separate to go to line. These should not be less than ten or twelve inches apart. The nearer together they are, of course the greater the possibility of either getting them crossed or getting them connected by some conductor. I have known a fireman to hang his wet shirt on two wires to dry—a trick which cost him a new shirt. The resistance of a wet cloth will develop heat as well as any other resistance. The wire in this case was insulated, but fire proof insulation is not water proof, and water proof insulation is not fire proof, except where the insulation is made so by covering with metal. Gas men, plumbers, carpenters, and engineers, while not willfully mischievous, often do great harm after a plant is established, by running pipes, rods, or other fixtures for pumps, soda fountains, gas, sewerage, water, or steam in close proximity to wires. They don't know any better, and they cannot be blamed, but must be watched. A short time since I found one of these large wires within about a half inch of a gas pipe. Normally it was safe. The space between the wire and the pipe was an excellent place in which to put an iron chisel, screw driver, or hammer. This would be quite natural. A wet towel would accomplish much the same result—create a ground connection, or what we technically call a ground.

Wires have sometimes been fastened to the plastered wall by iron staples. These may or may not be safe, temporarily, but it is not rare for the lathing in recent structures to be of wire, connected indirectly or directly to the ground. Wires running through damp places, as cellars, basements, etc., unless carefully guarded, are liable to form contact through dampness with water and gas pipes, either of which goes to ground.

Outside wires are full of expedients for getting a plant into trouble. Where they cross buildings, if there are other wires, either electrical or guy or stay wires, contact with these may mean a heavy loss in a block half a mile away. If the wire is a telegraph, telephone, police, or fire wire, its capacity for carrying is not equal to that of the electric light wire. If the current is deflected from its proper wire to the central office of the company whose wire is thus crossed, circumstances alone will decide what damage is to be paid for.

Some three years ago a small loss occurred which may serve to illustrate this phase of danger: A temporary line was run from a plant in the same block to furnish light for an evening entertainment. The wire was not insulated properly, and during the existence of this additional circuit a rain storm wetted the surface where the electric light wire rested, and formed a road for the current to a telephone wire. The telephone wire bore the indignity well enough until it reached the fine wire cable in the exchange. There it would withstand the insult no longer, and it burst into fire. The wire was too small to carry the current thrust upon it, and diminished size, as we have seen, means increased resistance, and resistance means heat. Ordinary water, then, may be made an element for producing fire. Why? Because it is a conductor of electricity, while wood, wool, silk, etc., are insulators when dry. Hence a wet wall, a damp board, even a dish cloth, might, under favorable circumstances, cause a severe loss to an insurance company. So, too, a wire on the face of a building is liable to come in contact with metal cornices, columns, posts, frames, etc., and I consider the long loops of wire which lead from a building to an outside lamp which is suspended from a rope particularly dangerous. These hangings are hazardous to both persons and property. The pulley rope, by which the lamp is lowered and raised, being no essential part of the light proper, is never looked after, as a rule, until the weather has perhaps materially reduced its strength, or it has given way. Some half a dozen or so of these have fallen in Chicago through the neglect of this rope.

A still worse feature in this form of hanging is the almost constant certainty of grounds where these wires flap against rods, frames, etc., and are wrapped up in the awning, which latter may be wet at any time. A remedy for this form of danger is found in a hanger manufactured by the Electrical Supply Company, which costs a mere trifle more than a plain rod. There is no reason why the underwriters should not demand the use of some such expedient as an additional element of safety.

I have frequently referred to the danger arising from a ground connection. Franklin, among other quaint thing, said: "Take care of the pennies, and the pounds will take care of themselves." One penny is but a small amount for either good or evil. One ground on a line can do no possible harm; and if we can keep the first ground at a proper distance, the second will take care of itself. I have said that the current which any conductor will carry is proportioned to its capacity—the same as a water pipe; and if we have two conductors, one twice as large as the other, leading from the same source, one of these will carry twice as much as the other. The ratio is in proportion to the capacity.

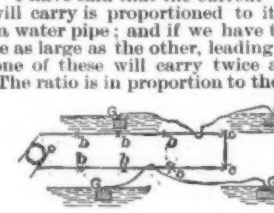


FIG. 4.

The current from the dynamo starts out on the line, and finds on its way a ground connection, say one-quarter of the way round. Three-quarters of the way round there is a similar ground. In this case a certain amount of current is cut off and goes to earth at each of these points, and the lamps in the farther half of the circuit are deprived of just so much current energy. The amount which will escape at these two points will be in proportion to the carrying capacity. If the grounds are good, they will cut out the lamps beyond them entirely. If the line is a better conductor than the ground, more current will traverse the wire than waste at the leaks. If one of these happens to be a telephone wire, a fire might be the result; and if one of them happens to be an underwriter, a funeral might be in order. But if either of these occurred, and there was no other ground on the line, there would be no work for either the adjuster or the coroner.

The incandescent circuit—and by circuit we mean the wires which carry a current—must also be kept free from contact with the earth. The current used by the incandescent systems is less fierce than that used by the arc systems. We say of steam at ninety pounds that its pressure is greater than at eighty pounds. So of electricity, we have what may be understood as high and low pressure. The highest pressure we can create is shown in that which is generated by a frictional machine, and comes nearest to that of nature. The lowest pressure is that which we accumulate by means of batteries, such as are used in telegraphy. We have quantity also, which is but another name for a result of low resistance. Now, the incandescent system uses a current of such low pressure that it is far more easily controlled and kept in the straight and narrow path than its wicked partner, the arc current. The wires, too, are differently placed. From either side of the dynamo the two wires are carried parallel out to the end of the circuit, say the upper floor of the building. They are not joined together at that point, but left open.

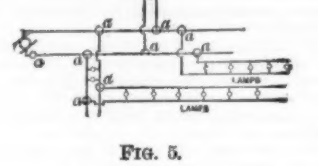


FIG. 5.

Now, from a given point on these, say the first floor, a wire is carried at right angles from each of the mains down the halls on that floor. Opposite each room we attach a wire to each of these secondary wires, and run them parallel to the end of the room.

In all this wiring we have made no connection between the ends of the wires; all these ends are open. Anywhere we like, governed by certain rules depending upon this matter of resistance again, we can put our lamps in, like rounds of a ladder; the branches leading into the room may be connected together by a dozen lamps, and the current has no way to get from one wire to the other, except to go over these little bridges, these lamps. There are modifications of this method, but they do not affect the question from our standpoint. You will naturally ask what safeguard there is in a system so placed. I answer this: At every point where there is a branch wire—at the junction—is placed a safety strip, which protects the wire from that point to the last branch from the dynamo.

The action of the safety strip is this: Being placed in the direct path of the current, it carries all which crosses that part of the circuit. Its carrying capacity is less than that of the wire, for it is made of a metal of higher resistance, and it melts at a lower temperature. If a screwdriver, or a nail, or any conductor is made to connect the two wires leading to the two sides of the generator, the resistance is reduced at that point. More current crosses at that point than is useful; the soft metal melts and cuts the line in two. A leak from a water pipe may form such a contact, and, before the building would be endangered, the increased flow of current would open the line, put out the lights on that branch, and cut off the dangerous current.

The soft or safety strip is graduated for the current it is intended to carry. Usually these are numbered for the number of lights they are designed to protect. The incandescent plant should not be allowed to run without safety strips under any circumstances. It is the custom of some companies to put the safety strip in the socket of the lamp. This is on the principle of fun for the boys, but death to the frogs. The lamp may be saved in case of excess of current, but the building may burn.

It is all well enough to place a safety strip in the socket of the lamp, but the strip at the junction should not be omitted on any account. Care should be taken to see that the wires do not run in such a manner or through such places as to allow of accumulation of dirt, lint, inflammable dust, etc. I once found, in part of an incandescent circuit, a large accumulation of material just such as a rat would select for a nest, in contact with the wires; and in an arc light circuit, where the two wires had dropped behind a store sign, I found a colony of sparrows. Were I asked, point blank, What faults shall we look for in a plant? I should hardly know what to answer, there are so many wrong ways of doing. These are so different, hardly occurring twice consecutively, that it is a matter of almost utter impossibility to answer such a question directly.

Two questions have been asked relative to the proper placing of a dynamo, which I will answer here. Outside the question of insulation, a dynamo may be looked upon as we would look upon any other rapidly revolving machinery. It should be as thoroughly insulated as any portion of the line, and must be considered as part of the line. It should be placed on a foundation selected and arranged so as not to endanger the building by vibration. The fire hazard is not increased by the dynamo, when this is properly protected by insulation. It has been sometimes suggested that an electric light system served to fill the air—saturate it, so to speak—with electricity, and thus endangered the building. As long as a line is insulated properly, so long the current will remain on the wire. With a ground elsewhere on the line, a second leak might occur in a damp—very damp—room, through the moist air to ground; but with a well-insulated line, this could not occur. With dry air, such a saturation would be impossible. Magnetism is always present in a room where a dynamo is, but this force is harmless to persons and insured property. It is, however, ruinous to good watches, the steel parts of which absorb and retain magnetism.

Some other questions, asking specific answers, have been propounded, which, without repeating, I will endeavor to elucidate. Where a line is of the central plant variety—by which name we designate a plant running lights for rentals for sundry parties—the wire is often quite long, and consequently exposed to atmospheric electric changes, which might possibly overcharge the wire. It is hardly probable that any result would occur other than the destruction of the dynamo. For the protection of these machines, it is well to put in what is termed the lightning arrester, which will carry off the excess of current in case of surcharging of the line from the atmosphere.

There have been many forms of arresters made, but none are thoroughly complete and reliable. The commonest form is made of three brass plates, with connections on the two outside ones, to the generator in

one direction and to the line in the other. The middle plate is connected direct to ground. The saw teeth are, by an electrical law, more competent for discharging a current than a plain surface would be. The objections to this form are that a heavy discharge may create an arc, which the normal current will afterward maintain, or the teeth may be welded to the ground plate by the discharge. These faults are easily remedied, however, by stopping the dynamo, and, as the arrester is in the room close to the dynamo, the trouble is manifested immediately, and readily cured. Mr. E. A. Sperry is

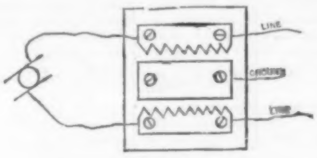


FIG. 6.

the inventor of an arrester which is claimed to act promptly and perfectly, without these objectionable features.

I have never heard of any injury to person or property from such causes, but the placing of such lightning catchers effectually protects from possible discharges of lightning. The current generated by the dynamo will not leave the wire, except through a ground. The current which is created in nature is on its travels, either from earth to cloud, from cloud to earth, or from one cloud to another; so that, with all the other routes open to it, it is hardly reasonable to expect it to single out a copper wire on its way to the heavens or into the ground. As a matter of protection to the firemen, on such long circuits, it is not a bad idea to require, placed at each building or block where the wires enter, a cut-off switch, which, being turned, completely cuts off the current from the locality or single structure; but even this, if wires are properly placed, is hardly necessary.

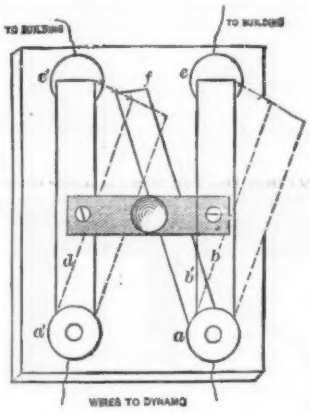


FIG. 7.

The cut-off switch may be of any form which will accomplish the complete separation of the building to be protected from the line. It differs essentially from a cut-out switch. The latter merely puts out the lights, but does not separate the building from the generator. In the cut shown, the wires come from either side of the dynamo to the building posts, *a a'*; *b b* are brass, and virtually one piece. There is a handle of wood or some other insulator, by which the switch is moved; *d* is another brass strip; *e e'* are two brass studs, to which the wires running into the building are connected. As the switch stands in its normal position, the current enters at *a*, passes through *b*, *e*, thence through the building to *e'*, *d*, *a'*, and back to generator. Now, when we push the switch over, we open the contacts at *e* and *e'*, but close the circuit at F, so that the current from the dynamo cannot get beyond that point.

To my mind there is but one sovereign panacea which can cure the ills of the electric light business. No plant should be permitted to run until a thorough inspection has been made by a competent electrician, with power to enforce his suggestions. And I believe it would be money in the treasuries of the fire insurance companies to be at the expense of such inspections, dividing this *pro rata* among the benefited companies, or on some modification of such a plan. I have not given the subject thought beyond this crude suggestion. In my opinion, no wire for electrical purposes should be allowed above ground. While these are permitted to swing in the air from poles and house tops, contact with other wires is almost certain; and where these are telephone, telegraph, or other grounded lines, the result, if one such is crossed with an electric light wire, might be disastrous. With these in the ground, the wind and weather can have no effect, and such a thing as a cross would be next to an impossibility.

In conclusion, it seems to me, if I may be allowed to express an opinion, that the insurance companies are quite the proper parties to urge both these points, and they certainly can, if it is deemed expedient, control the former. The experience in Chicago is certainly well worth attention and consideration.

DOMESTIC ELECTRICITY.

A New Style of Electric Bell.—The usual form of electric bells is far from being pleasing, and for this reason an effort has been made to modify their shape and arrangement, so as to give them a somewhat more acceptable aspect.

One of the most successful types in this line is Mr. Jensen's device, in which the entire mechanism is inclosed and wholly concealed in a nickel-plated bell of ordinary shape, having an agreeable sonorousness. In this bell the mechanism consists of an electro-magnet and a single bobbin with an oscillating armature, and its operation is identical with that of an ordinary vibrating bell with a double electro. The bell is, as a usual thing, suspended from an ornamental bracket, and by this means the proper communications are established with the two wires that connect the pile and button.

This apparatus is constructed in all sizes. Its advantages reside in its simplicity, in its pleasing aspect, that permits of its being placed in the richest apartments without prejudice to the decorative effect, and

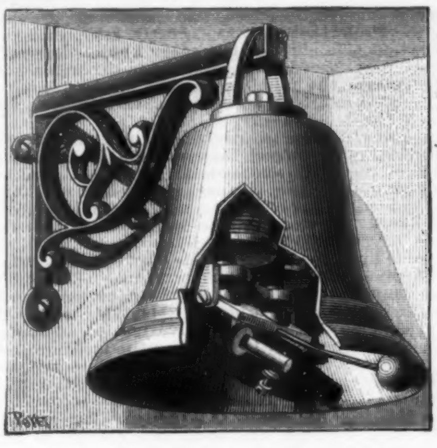


FIG. 1.—JENSEN'S ELECTRIC BELL.

in its sound being more musical and less strident than that emitted by ordinary call bells.

New Terminals and Wire Clamps.—All amateurs who are making experiments with ordinary currents of slight intensity know how inconvenient the usual terminals and wire clamps are, and how much loss of time they occasion. As an improvement upon these, Mr. Radiguet has devised the apparatus shown in Fig. 2. No. 1 represents an ordinary terminal without a binding screw. In the interior of this there is a cavity that contains a small spring provided with a brass rod which projects externally. It is only necessary to press upon this rod, and introduce a wire into the aperture, and then free the rod, in order to fix the wire firmly and give an excellent electric contact through the spring that presses against the aperture.

The form of the spring and its rod is shown at *r*. No. 2 is a similar, but still simpler, terminal, in which the pressure is exerted by a spiral spring that it is only necessary to depress in order to free the aperture into which the wire is passed. The spring, upon being freed, exerts the necessary pressure to secure a perfect contact. Nos. 3 and 4 represent wire clamps designed

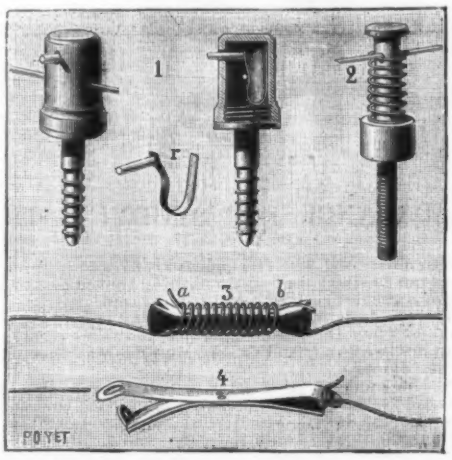


FIG. 2.—NEW FORMS OF TERMINALS AND CLAMPS.

to form a connection between two loose wires. No. 3 reproduces in double form the spiral spring device of No. 2. The spring is compressed in one direction, and then in the other, in order to successively secure the two wires in the apertures *a* and *b*, and thus effect a connection between them.

On the contrary, No. 4, in its arrangement, recalls the terminal No. 1. A slightly curved strip of brass is bent at right angles at its extremities, and in each of the latter there is an aperture. A spring fixed to the middle of this piece likewise contains two apertures in its extremities. Upon pressing this spring and inserting a wire in the aperture in the strip, the spring is kept tightened and the wire is pressed against the brass piece.—*La Nature.*

FLUORESCENCE OF THE COMPOUNDS OF BISMUTH EXPOSED TO THE ELECTRIC EFFLUVE IN A VACUUM.

BISMUTH sulphate, previously heated to dull redness, does not fluoresce in a vacuum. A very small quantity of bismuth sulphate communicates to calcium sulphate the property of emitting a very fine fluorescence of an orange red. Bismuthiferous calcium carbonate yields only a violet fluorescence, differing little from that produced without the bismuth. With bismuthiferous strontium sulphate the fluorescence is still more brilliant than with the calcium salt, and inclines to an orange. Bismuthiferous barium sulphate gives a very fine fluorescence of a red less inclining to orange than that obtained with the calcium salt. Bismuthiferous magnesium sulphate fluoresces with a still more purely red light.—*Lecoq de Boisbaudran.*

DISTRIBUTION OF THE NITRIFYING ORGANISM IN THE SOIL.*

By R. WARINGTON.

PREVIOUS experiments, conducted at Rothamsted on this subject (*Trans. Chem. Soc.*, 1884, p. 645), had led to the conclusion that the nitrifying organism is always to be met with down to 9 inches from the surface, and that at 18 inches it is sometimes present; but experiments with soil 2 to 8 feet from the surface failed to yield evidence of the presence of the organism.

Further experiments have been made in 1885, and during the present year, both in the field with the stiff clay subsoil previously worked on and in another field having a loamy subsoil; in all, sixty-nine new experiments have been made. The soil in the previous experiments was removed, with suitable precautions, from a freshly cut surface, and placed in sterilized solution consisting of dilute durine (0·4 per cent.). It having since been found that the facility with which urine nitrifies is greatly increased by the presence of gypsum (*Trans. Chem. Soc.*, 1885, p. 758), an addition of a small quantity of gypsum was made to the solutions employed in all the recent experiments. Rather larger quantities of soil were also employed. The results may be summarized as follows:

Depth of soil.	Number of experiments.	Number of solutions nitrifying.	Number nitrifying out of ten trials.
Less than 2 feet	17	17	10·0
2 feet	11	11	10·0
3 "	11	10	9·1
4 "	11	7	6·4
5 "	2	1	5·0
6 "	9	4	4·4
7 "	2	0	0·0
8 "	6	0	0·0

Six of the above experiments were made with chalk, which underlies the Rothamsted subsoil. The chalk was from depths of 5, 6, 7, and 8 feet. None of the samples of chalk produced nitrification.

The new results show a far deeper distribution of the nitrifying organism than was concluded from the earlier experiments. The power of producing nitrification is now found to exist generally down to 3 feet from the surface. Below this point the occurrence of the organism becomes less frequent, though at 5 and 6 feet about half the trials resulted in nitrification. With soil from 7 and 8 feet no nitrification was obtained. The considerable difference between the earlier and later results is to be attributed to the employment of gypsum in the later solutions. The nitrifying organism in the subsoil is indeed less abundant, and probably much more feeble than in the surface soil, and is apparently unable to start nitrification in the decidedly alkaline solution which urine produces in the absence of gypsum.

Although it appears that the nitrifying organism may exist at considerable depths, nitrification is practically confined to the surface soil. The quantity of nitrogen as nitric acid annually obtained in the drainage water from soils of different depths in the drain gauges at Rothamsted is on an average of nine years:

Soil 20 inches deep	40·2 lb. per acre.
Soil 40 " "	35·0 " "
Soil 60 " "	38·8 " "

There is no evidence here of a greater production of nitrates when the subsoil is included in the experiment.

Nitrates are always found most abundantly in the surface soil, unless heavy rain has occurred to wash them downward. Two fallow soils at Rothamsted were found to contain the following quantities of nitrogen as nitrates in pounds per acre:

1st 9 inches	28·5	40·1
2d "	5·2	14·3
3d "	—	5·5
Total	33·7	59·9

THE SOCIETY OF CHEMICAL INDUSTRY.

THE opening meeting of the session of the Manchester branch of the Society of Chemical Industry was held Oct. 30, at the rooms of the Chemical Club, Victoria Buildings. There was a large gathering of the members of the society and their friends.

Sir Henry E. Roscoe, M. P., who presided, opened the proceedings with a brief address.

In the absence of Mr. Ivan Levinstein, the vice-chairman, Mr. Watson Smith read some notes prepared by that gentleman on the subject of two chemical substances recently introduced into the field of chemical industry. The first substance is a new compound called

SALOL,

which he described as an anti-rheumatic *par excellence.* Explaining its chemical constitution, the process of its manufacture, and its general properties, he specially directed attention to its antipyretic, antiseptic, and anti-rheumatic qualities. It acts not only more powerfully than salicylic acid in acute and chronic rheumatism, but it possesses the very great advantage over this hitherto considered most valuable drug in the treatment of acute rheumatism, that it does not cause any disturbance of the digestive functions, which, unfortunately, in very many cases prohibits the use of salicylic acid. Being insoluble in water, it passes unaltered through the stomach, and is afterward decomposed by the ferments of the pancreas. It is also a powerful antiseptic, and being neither caustic nor irritating to the skin, it may be found, Mr. Levinstein thinks, of the highest value for surgical operations. The next new chemical substance to which Mr. Levinstein referred was

LANOLINE.

This substance in its pure state was, he said, known to chemists and physiologists for many years as cholesterin, and is found present in the animal as well as in the vegetable kingdom. Liebreich observed that cholesterin absorbs more than 100 per cent. of water, and he called this combination of pure cholesterin and water "lanoline." The credit was also due to him of having first called attention to its therapeutic properties. He also showed its presence in the human epidermis, in

* Read before the British Association, Birmingham meeting, Section B.

hair, whalebone, etc. Lanoline, or cholesterin, was known previously to exist in the hair, in blood, in bile, and gallstones. The latter principally consist of cholesterin, and have hitherto furnished the material for obtaining it for scientific purposes. Cholesterin is also found in large quantities in wool grease, and this now furnishes the material for the industrial manufacture of lanoline. Mr. Levinstein described the method of preparing pure lanoline from wool grease, and after describing its general qualities, he referred to the one remarkable property on which its great value principally depends, and which puts it at once above vaseline, paraffin, lard, etc., for all medicinal or therapeutic purposes, viz., its very quick absorption by the skin. While vaseline or petroleum jelly, for instance, directly hinders the passage of medicaments into the skin, so that even some poisonous substances mixed with vaseline and rubbed into the skin produce neither local nor general symptoms of poisoning, lanoline is absorbed by the skin with the greatest ease. So marked is its power of penetrating the epidermis, that when mixed with poisonous drugs only about half the usual proportions should be prescribed in ointments. It was, however, necessary that the lanoline should be pure. There had existed for a number of years all kinds of preparations under various names, such as wool fat, wool oil, etc., but these contain impurities which are directly injurious. Already lanoline has found application in ointments, plasters, salves, etc., and it has also been introduced as a commercial product into various branches of industry, such as perfumery, soaps, creams, pomades. It was impossible to foresee, indeed, the manifold applications which it may yet find in medicine, arts, and manufactures. Another substance Mr. Levinstein briefly alluded to was the very latest febrifuge, viz., the

ANTIFEBRINE

which has been known to chemists for a number of years as acetanilid, and which is said to be the most powerful agent for reducing the temperature of the blood.

Mr. Watson Smith demonstrated two new tests for the identification of resorcinol and thalline, one of the new antipyretics, and their distinction from phenol (carbolic acid) and the other antipyretics or febrifuges, antipyrine, kairine, and antifebrine. The reagent employed was beta-naphthoquinone, dissolved in water to form a dilute solution. On adding resorcinol dissolved in water, no change occurs until a few drops of ammonia are run in, when a fine bluish green color is developed, changing to a fine red on acidifying with nitric acid. Ether or chloroform dissolve out the color, and float or sink, forming red-colored layers. With thalline tartrate or sulphate, on addition of a few drops of caustic soda to the quinone solution, a fine red color develops, the beauty of which is heightened by acidifying with nitric acid. Ether and chloroform extract the color, as in the case of resorcinol. Neither phenol, naphthol, nor the other bodies named give any color changes, and Mr. Smith pointed out the value of the tests in therapeutical chemistry, and also showed how in the case of salol, referred to by Mr. Levinstein, a salol made from phenol could readily be distinguished from one made from resorcinol by the application of one of the foregoing tests, after a fusion with pure potash.

EXPERIMENTS ON THE CIRCULATION OF THE BLOOD.*

By Professor MOSSO.

No one has as yet thought of studying the circulation of the blood in the hands and feet, because even the most practiced eye cannot discern therein, with certainty, slight variations in the color of the skin, and the thermometer, when applied to the surface of the body, is not capable of furnishing an accurate indication.

Thinking that I might succeed in doing so by measuring the variations in the size of the hand, I selected a long and narrow vessel, and removed the bottom from it. Into this I introduced the hand and forearm, and then closed the vessel hermetically with glazier's putty. The neck I closed by means of a cork, through which ran a long, narrow tube, and then I filled the whole with tepid water. I thought to myself that if a larger quantity of blood should flow to the hand, the arteries, capillaries, and veins would increase in size, and cause a corresponding quantity of water to make its exit from the vessel; and, on the contrary, if the blood vessels should contract, that the hand would become smaller, and allow the water contained in the tube to re-enter the vessel. The first experiment that I performed was upon my brother, and this persuaded me that I was not deceived. I was then far from supposing that it would soon be possible for me to raise my humble apparatus to the dignity of a scientific method, and to write, owing to it, a new chapter in physiological treatises.

I have no desire to carry the reader too far, by acquainting him with the improvements introduced into the apparatus, which I have named the *plethysmograph*, or "measurer of changes in bulk."

A few months after this first experiment, I returned to Leipzig, and visited the celebrated physiologist Ludwig, in order to impart to him the idea that had occurred to me of a very simple instrument, by means of which it would be possible to obtain graphic curves of the motions of blood in man. I shall always recall with deep feeling the look of satisfaction with which he followed upon the paper the figure that I traced with a trembling hand, in order to make myself understood; how highly delighted he was, and the kindliness with which he induced me to complete my studies in his laboratory.

I quickly set to work and constructed two apparatus, one for each arm, in order to be able to study the circulation simultaneously in both parts of the body. The phenomenon that had greatly surprised me in the first experiment in Italy was the extreme sensitiveness of the vessels of the hand, which caused a surprising change in the size of the latter after the slightest mental disturbance, either while the subject was awake or asleep.

A few days after my occupancy of the laboratory in Leipzig, I performed an experiment in a room adjoining the professor's study. My companion in study, Prof. Luigi Pagliani, entered into all the experiments with the devotion of a friend. I wished in the first place to ascertain what relations exist between respiration and the change in the size of the hand. While Prof. Pagliani was standing in front of the registering apparatus, with his arms in the glass cylinders filled with water, Prof. Ludwig entered. All at once the two pens that indicated the size of the arm descended and left upon the paper a vertical black line about four inches in length. It was the first time that I had seen so great a diminution in the size of the hand and forearm though the effect of an emotion apparently so slight. Prof. Ludwig was greatly astonished, and, with that affability that renders him so dear to his pupils, took a pen and wrote upon the paper, at the point where the plethysmograph had indicated his entrance, through the change produced in the circulation, "The lion comes!"

In order to more clearly show the continuous displacement of the blood that accumulates, now at one point of the body, and now at another, I have constructed quite a large balance, which consists of a long and wide table, upon which a man can lie, as shown in the figure. By means of the weight, R, which can be made to slide along the edge of the table, which is movable upon the point, E, it is easy to keep a man in equilibrium when the center of gravity of the body is near enough to the middle of the balance. In order that the latter may not incline to one side or the other at every slight oscillation, I have had to add a large metallic counterpoise, I, which may be raised or lowered by means of a screw thread upon the axis, G H. This latter, which is fixed vertically in the center of the table, D C, is firmly held by the lateral rods, M L.

In this way, the center of gravity of the balance is sufficiently lowered, and does not change at every slight oscillation, since the counterpoise acts in a direction contrary to the inclination of the balance and makes it horizontal again. I have given this balance such a degree of sensitiveness that it oscillates freely according to the rhythm of the respiration.

If a perfectly calm person, lying horizontally upon the balance, and reposing in equilibrium, be spoken to, the balance will at once incline at the end toward the head, the legs becoming lighter and the head heavier. And this phenomenon always occurs, even when the subject submitted to the experiment takes every precaution not to move, and when he endeavors to hold his breath so as not to speak, and to do nothing that might bring about a greater rush of blood to the brain.

The spectacle was ever an interesting one to my colleagues when they came upon me unawares in my researches, while a friend or acquaintance was asleep upon the balance.

At the moment of a siesta, which is preferable for this kind of observation, it often happened that some one who was drowsy would be rocking through the uniform oscillations of this scientific cradle. But hardly had any one touched the door in order to enter than the balance would incline at the end toward the head and remain immovable in such a position for five, six, or even ten minutes, according as the disturbance occurred while the slumber was more or less profound. If the subject awoke, it often occurred that the blood would not distribute itself as before, and it became necessary to move the weight, R, toward the feet, whence the blood had flowed to the brain. Then, gradually, if he went to sleep again, the balance would return to its position of inclination toward the feet. The blood, so to speak, left the centers of activity and became more abundantly distributed in the veins of the feet, which it congested. It was necessary to diminish the weight, R; and finally, during deep slumber, the distribution of the blood peculiar to this state of our system became re-established. At the same time, the respiratory oscillations became prolonged in a continuous manner. Then, while everything was silent, one of us would make a slight noise, such as coughing, shuffling the feet, or moving a chair. Then the balance would descend toward the head and remain immovable for four or five minutes, without the subject being aware of it. While all has been silent, during the night or at the time of a siesta, I have often observed that, without any external cause, oscillations occur as a consequence of a spontaneous movement of the blood dependent upon a dream or a psychical phenomenon that acts upon the vasomoter nerves and modifies the circulation without any participation of consciousness, or, at least, without any trace of such work remaining in the memory.

My balance has demonstrated that the slightest disturbance causes a flow of blood to the brain. But this did not satisfy me. I desired to analyze this phenomenon more in detail, and so I constructed other apparatus for studying all the peculiarities of the course of the blood rushing from the hands, feet, and arms toward the brain.

I have observed a pulse for hours at a time, not at a single point, but at every point of the body, in the brain, in the hands, and in the feet, and have watched the slightest modifications that the activity of thought, external impressions, noises, and dreams produce in the blood vessels.

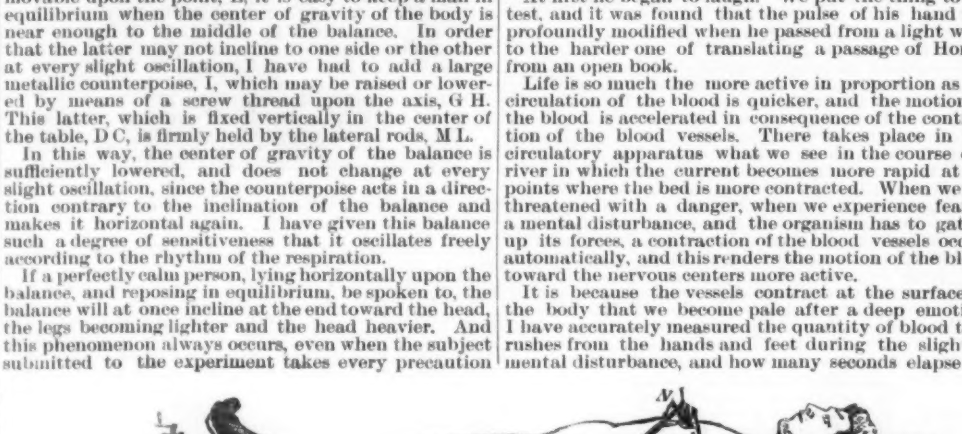
It is well known that the beats of the heart increase during digestion, but no one has hitherto observed the modifications that the form of the pulse undergoes. I have found these so characteristic that I now make bold, upon seeing the tracing of a single pulsation of the hand or foot, to say whether the person was fasting or not. And even, upon seeing two pulsations, I can distinguish that of the man who reflects from that of the heedless man, that of the man awake from that of the man asleep, that of one who is cold from that of one who is warm, that of one who is agitated from that of one who is calm, and that of one who is frightened from that of one who is tranquil.

One of my friends, who is occupied with literature, came to my laboratory to see me one day, in order to satisfy himself with his own eyes concerning these facts, which did not seem to him very credible. I made an experiment upon him in order to see whether there would be any difference in the form of his pulse according as he was reading an Italian or a Greek book.

At first he began to laugh. We put the thing to the test, and it was found that the pulse of his hand was profoundly modified when he passed from a light work to the harder one of translating a passage of Homer from an open book.

Life is so much the more active in proportion as the circulation of the blood is quicker, and the motion of the blood is accelerated in consequence of the contraction of the blood vessels. There takes place in our circulatory apparatus what we see in the course of a river in which the current becomes more rapid at the points where the bed is more contracted. When we are threatened with a danger, when we experience fear or a mental disturbance, and the organism has to gather up its forces, a contraction of the blood vessels occurs automatically, and this renders the motion of the blood toward the nervous centers more active.

It is because the vessels contract at the surface of the body that we become pale after a deep emotion. I have accurately measured the quantity of blood that rushes from the hands and feet during the slightest mental disturbance, and how many seconds elapse between the moment at which the disturbance occurs and that at which pallor supervenes; but this is not the place to give figures.



BALANCE FOR STUDYING THE CIRCULATION OF THE BLOOD.

A lady once told me that in a paroxysm of fright she had taken from her finger a ring which, before that, she could not have removed without a great effort. And she observed that the finger became really smaller and the ring easier to remove every time her mind was greatly disturbed.

The proverb that a cold hand denotes a warm heart is the popular expression of the fact that the hands really become cold when, through the effect of an emotion, the blood leaves the extremities of the body to go to the heart.

* From *Revue Scientifique*.

ON FERMENTATIONS AND BACTERIA.

By W. BERNHARDT.

THERE are numerous natural processes which, although every day occurrences, and well known to all of us, have not yet been sufficiently explained for general understanding, and which as yet are far from being scientifically enlightened. Among them are those phenomena signified by the collective notion of "fermentation," an expression originally applied only to a few chemical changes, but subsequently extended to many others resembling them. The modern meaning of the word includes processes of very different kinds, all of which agree in their occurring in matter of organic origin by action of nitrogenous agents, called ferments.

With particular interest have chemists and people in general, from ancient times till to-day, observed these transformations of matter by fermentation; the deep mystery surrounding them on one hand being attractive, the practical importance of some, and the deleterious effects of several of them, on the other hand, provoking attention. Discoveries of the last years have increased the zeal of penetrating into their nature, and researches now in work promise results of the utmost value to mankind.

An important difference concerning the character of these ferments permits to divide them into two classes, into such as are not organized, but amorphous matter, which in water solution unfolds its decomposing activity, and into living organisms belonging to the natural class of fungi (schizomycetes). These two classes of ferments moreover differ from each other in a further respect, the former of them only decomposing a limited quantity of matter, the latter, on the contrary,

producing decomposition in infinite supplies of the compounds exposed to their action. This difference, however, must only be regarded as a practical, not a scientific one, as it only depends on the increase of active substance by propagation of the micro-organisms, young individuals continuing action after the decease of their mother organisms. Function of living ferments therefore is also limited to a certain extent. Fermentation of every kind, provided that the necessary conditions of warmth and some other requisites are present, lasts until the supply of food is exhausted, or until the ferment itself has become inactive. The effect of every ferment is bound to certain matter, the final products of every one's action being always the same. The fungus which transforms sugar into alcohol and carbonic acid is of no influence upon other substances; pepsin acts dissolving only upon albuminous compounds, not upon starch, cellulose, or fat. All not organized ferments are compounds formed in the vital process of plants or animals; organized ferments are vegetating microscopical beings, small fungi, the fertile germs of which are widely spread throughout soil, water, and air, from where they find their way to any matter convenient for food; they are nearly related to the vegetable forms of mould and rust.

Among the various not organized ferments of vegetable origin there are some of high practical interest, of which diastase deserves to be mentioned—a body formed during germination of grain. Its action consists in turning starch into sugar, a function which is practically applied in the brewing process. The juice of some kinds of fig trees, as, for instance, Carica papaya, contains papayotine, a ferment of the remarkable property of dissolving muscular fiber and boiled albumen. This effect has been therapeutically used for dissolving morbid membranes, such as appear in certain diseases (diphtheria). A very similar ferment is found in carnivorous or insecticide plants, in the leaves of Drosera, Nepenthes, Utricularia, and Venus' fly trap. It serves to dissolve the bodies of insects which happen to come in contact with the viscid secretion of the flowers of these plants. Besides these, there is an abundance of other fermentative bodies occurring in plants, some of them permanent constituents of whole classes or families, others peculiar only to certain genera or species.

In animal saliva and in other digestive juices a ferment occurs very much resembling diastase, and to which, from this reason, the same name has been attributed. Its action also consists in transforming starch into sugar. Pepsine and pancreatine, the ferments of stomach and pancreatic gland, dissolve muscular fiber and albuminous matter. The decomposition of blood caused by the bite of venomous serpents is due to a ferment preformed in particular glands, situated in their jaws. It is to similar agents that we probably have to ascribe the inflammations of wounds produced by various other animals. Also the outbreak of hydrophobia is certain to depend on communication of some ferment.

Processes not more uncommon than those mentioned, but, in many instances, by far more pernicious to mankind, are those depending on fermentations produced by living micro-organisms. Yet some of them are used on a large scale; so is production of alcoholic liquids from sugar effected by the fungus of yeast (saccharomyces), manufacture of vinegar by mycoderma aceti, and the formation of lactic acid in vegetable matter as well as in milk by bacillus subtilis.

Proceeding to organized ferments active in animal and human body, we enter a territory which has but since few years been explored, the researches hitherto performed nevertheless having resulted in discoveries of deciding influence upon the governing opinions on the origin, nature, and treatment of diseases. These organisms, microscopical members of the class of fungi, and also known by the names of bacteria and microbia, are, according to their shape, subdivided into micrococci, round corpuscles, bacilli, or rod-like bodies, spirilli, or spirally turned threads, etc. Germs of bacteria are, as it appears, present everywhere on the surface of the earth. Their vital energy enables them to resist heat and cold, dryness and moisture, for months and even for years without developing to grown individuals of their kind. As soon however as they enter a surrounding which affords food, germination and growing will begin, and if circumstances are favorable, in a short time produce millions of bacteria from a single germ. Some of these organisms are satisfied by various kinds of food, while others require a food of particular character for thriving. In certain so-called infectious diseases of men and animals there are constantly the same kinds of bacteria to be found, from which reason the supposition appears justified that there is a certain causal connection between those diseases and bacteria, and indeed experiment has proved that certain diseases may be artificially produced by transferring such bacteria into the blood of a healthy animal. In some infectious diseases, however, such as measles and scarlet fever, no special bacterium has yet been discovered.

The manner in which microbia manifest their sickening effect, according to the opinion of exact observers, consists in withdrawing essential constituents from tissue and juices, in consuming them for their own growth and propagation, and in giving out secretions of more or less virulent character. The pernicious effect of their presence may consist both in mechanical destruction and in chemical decomposition of its solid and liquid constituents, both actions being mostly combined.

Although the outset and spreading of certain diseases seem to be convincing evidences of their microbial origin, there is no reason to conclude that the presence of bacteria in all cases proves them to be the cause of the disease. They appear everywhere where their germs are present and find nourishment. Any interruption of the normal state of health, be it brought on by a cold, by dietetic irregularities, by extraordinary efforts, or by other circumstances, may induce a disposition favorable for development of bacteria, to which a healthy system would successfully resist. In such a case bacteria are not the original cause of sickness, but by their accession they may aggravate suffering and increase danger. We may expect that as surely as those various bacteria which are formed in the digestive organs of animals are considered of little or no influence in digestion, but as harmless parasites, as surely may many others, some of which were suspected injurious, prove indifferent to health. Considering the prominent part which chemical changes play in nutrition and elimination, and pondering the fact that modern physiologists declare even cells, the elementary organs of body, to be endowed with fermentative power on albuminous matter, we may conclude that also in diseases such chemical functions of not organized ferments are of prevailing influence, and that bacteria frequently only act as communicators of such a ferment. This assumption would explain the fact that in many cases of infection bacteria are present in great number, while in other cases of the same kind they are not found.

Not only by proving the existence of ferments and by pursuing their effects in living and dead organic matter has science rendered important service to mankind, but not less so by studying the conditions upon which these actions depend, and the means to increase or to impeach them according to their usefulness or injuriousness. Considering the invaluable merits of antiseptic treatment in surgery, by which millions of human lives have been saved, we are forced to recognize the blessing which we already owe to the knowledge of germicide substances, and we are entitled to the highest expectations from further accomplishment of this class of researches.

A RAMBLE IN THE FIELD OF ETYMOLOGY.

THERE are, perhaps, comparatively few readers of a scientific journal like this who, if asked, would be able to give the derivation and actual meaning of the names of some of the commonest tools, apparatus, and mechanical devices with which most of them are perfectly familiar, through daily use or otherwise. Yet this is not to be wondered at, since the lapse of time has so changed the form of the names of many of the objects which we daily see or use that the words no longer suggest a meaning to us, but have arrived at a stage where they are apt to be regarded as mere arbitrary designations, serving only as distinguishing marks, and nothing more. Thus, to borrow an example from natural history, when the name of the *squirrel* is mentioned, the image of the animal itself at once presents itself to our mind, but the meaning of the name ('shade-tail') accompanies neither the image nor the name unless we have had the curiosity to ascertain it previously; and the same is the case with the names of a large number of the objects which we daily use at home and in the shop. Again, the same cause (lapse of time) has operated in some cases to make names quite independent of the reasons for which they were given, and has robbed them of their original significance. Thus, the *carpenter* is no longer, as he originally was, a cartwright—a maker of *carpenta*, 'wagons'—the *forge* is no longer a mere workshop (*fabrica*), the *screw* is no longer a hole in the ground, and the *vise* has grown to be something more substantial than a tendril. Thinking, then, that the subject might prove of interest to our readers, we have made a random selection of a few technical terms, and herewith present them, along with their original meaning.

ANVIL.—An iron block upon which metals are hammered. From O. Eng. *anvild* or *anvilt*, with loss of terminal *d* or *t*; Ang. Sax. *anfilte*, from *an*, 'on,' and *fyllan*, 'to strike down.'

AUGER.—A tool for boring holes. A corruption of *nauger*; from Ang. Sax. *nafegar*, 'nave-piercer'—the tool having originally been used to bore holes in the center of a wheel.

ARBOR.—An axle upon which a wheel turns. From Lat. *arbor*, 'tree,' then a 'mast,' and next a cylindrical piece of wood used as an 'axle,' and finally a piece of metal of the same shape.

AXLE.—The axis upon which a wheel revolves. O. Eng. *axel*, Ang. Sax. *eaxl*, the 'shoulder.' So named in analogy with the shoulder-joint, which is the axis upon which the arm turns.

BELLOWS.—A device for blowing. A plural form of O. Eng. *below*, from Ang. Sax. *bælig*, 'bag.' (*Bag*, *belly*, and *bellows* are all variants of the same Ang. Sax. word.)

BIT.—A tool for boring holes. From Ang. Sax. *bitan*, 'to bite.' In the word *quillbit*, the first half of the compound is derived from Fr. *cuiller*, 'spoon.'

BOLT.—A bar or pin used for fastening. Literally, a 'knob;' originally, a round-headed arrow for a crossbow. From a root meaning 'round.'

BRACE.—A bit-stock. The sense of the word is 'that which holds firmly, as with the arm;' from O. F. *brace*, 'arm,' from Lat. *brachia*, the 'arms' (extended).

BRAKE.—A contrivance for stopping or retarding motion. From O. Du. *brake*, 'clog,' 'fetter.' From the same root as *break*, the apparatus being one that breaks motion.

BROACH.—A steel tool for smoothing or enlarging holes in metal. So named from its tapering shape, from Fr. *broche*, a 'spit,' from Low Lat. *brocca*, a 'needle,' from Lat. *broccus*, a 'point,' 'sharp tooth.'

BUSH.—A metal *box* in which an axle works. From Du. *bus*, a 'box,' from Lat. *buxis*, from Gr. πύξις, a 'case,' so called from having been made of boxwood, πύξος.

CAM.—A projection on a wheel, for giving a variable motion. From Dan. *kam*, 'comb,' 'ridge;' hence a ridge or cog on a wheel. The word is cognate with Eng. word *comb*.

CHISEL.—A cutting tool. From O. Fr. *cisel*, which is from a supposed Low Lat. *cæsellus*, from *cæsus*, participle of *cædere*, 'to cut.' (*Scissors* is a corruption of *cizars*, and is merely a plural form of *chisel*.)

CHUCK.—A device fixed to the mandrel of a lathe, for holding the material. Same as *chock*, a 'wedge,' so called from being driven home with a *shock* (Fr. *choc*), or blow. A word of Teutonic origin.

COG.—One of the teeth on the rim of a wheel. From Celtic *cog*, meaning, originally, a 'notch.'

CRAMP.—An instrument for compressing the joints of framework. From Teutonic root *kramp*, 'to squeeze.' Allied to the word *clamp*.

CRANK.—An arm *bent*, and fastened to an axis to produce motion. The word means 'that which is bent;' from Teutonic root *krank*, 'to bend,' 'to twist.'

DRIFT.—A tool for enlarging or shaping a hole by being *driven* into it; whence the name, from O. Eng. *drifen*, 'to drive.'

ENGINE.—A mechanical contrivance for applying power to produce a certain effect. From O. Fr. *engin*, 'tool,' 'engine,' from Lat. *ingenium*, 'invention,' 'good idea;' literally, 'that which is inborn' (from *in*, 'in,' and *genere*, 'to beget,' 'to engender').

FELLOE or FELLY.—The rim of a wheel. From O. Eng. *felwe*, from Ang. Sax. *felgu*, from *feolan*, 'to stick.' So called because the rim is made in pieces, which are afterward assembled or stuck together.

FLANGE.—A projecting edge or rim. A changed spelling of provincial English *flanch*, a 'projection,' a form of *flank*, from Fr. *flanc*, 'side,' literally, the 'weak part' of the body, from Lat. *flaccus*, 'flaccid.' The sense of the word is 'side piece.'

GEAR.—A toothed wheel, or toothed wheels collectively. The word means, literally, 'whatever is *prepared* for use or wear'—dress, harness, tackle, etc. From Ang. Sax. *gearwe*, 'preparation.' The equivalent of Lat. *apparatus*, meaning 'preparation.'

GIMLET.—A small tool for boring holes. From O. Fr. *guimbelet*, which (French *gu* corresponding to Teutonic *w*) is a diminutive formed from *wimble*, an instrument for boring holes, from Dan. *vimmel*, an 'auger.' The word is thus ultimately of Scandinavian origin, and means a 'winder' or 'turner.'

GIN.—A device for raising and moving heavy weights. An abbreviation of *engine*.

GOUGE.—A chisel with a hollowed blade. From Fr. *gouge*, Low Lat. *guvia*, a 'chisel,' from an earlier form, *gulbium*, a word of uncertain origin, but connected by some authorities with Celt. *gulpan*, 'sharp point.'

GUDGEON.—The journal at the end of a wooden shaft. O. Eng. *gojone*, the 'axle' of a pulley, from O. Fr. *goujon*, the 'axle' of a pulley, from Lat. *gobionem*, accusative case of *gobio*, from Gr. κωβιός, the name of a fish, transferred metaphorically to machinery.

HAMMER.—An instrument for driving nails. From Ang. Sax. *hamor*, a word of common origin with Du. *hamer*, Ger. *hammer*, Dan. *hammer*, Swed. *hammare*, and connected by some authorities with a Sanskrit word meaning a 'pointed stone.' If this is correct, the primitive hammer would have been a stone.

HINGE.—The joint on which a door, gate, etc., turns. O. Eng. *henge*, so named because something *hangs* upon it; from O. Eng. *hengan*, 'to hang.' In the O. Eng. word the *g* was hard.

HUB or HOB.—The nave of a wheel. A word of the same origin as *hump*, and meaning a 'projection,' the nave being that part of a wheel which *projects* from the center.

JACK.—Once the familiar cognomen of a man-servant whose duty it was to turn the spit, and now used to designate numerous apparatus that supply his place. From the personal Fr. name *Jacques*, Lat. *Jacobus*, Gr. Ἰάκωβος, from Heb. *Yaaqōb*, meaning 'one who seizes by the heel.'

JOURNAL.—That part of a shaft which revolves in a support. From Fr. *journal*, meaning, properly, 'that which takes place daily,' from Lat. *diurnale*. A metaphorical application of the word.

LEVER.—A bar for raising weights. From O. Fr. *leveur*, 'lifter,' from Lat. *levatorem*, accusative case of *levator*, 'lifter,' from *levare*, 'to lift up,' 'to lighten,' deriv. from *levis*, 'light.' Literally, then, the *lever* is 'that which *lightens* the load to be lifted.'

LUG.—A projecting piece in machinery; that which projects like an ear. From Scotch *lug*, 'the ear,' a word of Scandinavian origin, meaning the 'forelock.' Hence the verb *to lug*, which originally meant 'to pull by the hair.'

MALLET.—A wooden hammer. Formerly *maillet*, from Fr. *maillet*, a diminutive of *mail*, a 'mall' or 'beetle,' from Lat. *malleum*, accusative case of *malleus*, 'hammer,' from a root meaning 'to pound.' Literally, the *mallet* is the 'little pounder'

MILL.—In modern usage, a designation for various machines for transforming some raw material into a condition for use; properly, and originally, a machine for grinding grain. An alteration of O. Eng. *miln*, Ang. Sax. *myln*, from Lat. *molina*, from *molere*, 'to grind.' *Mule*, the name of the machine used in spinning, is the same word introduced through Ger. *mühle*, 'mill.'

PAWL.—A short bar used to prevent the recoil of a wheel, etc. From Welsh *pawl*, 'pole,' 'stake;' cognate with Lat. *palus*, 'stake,' whence Eng. *pole*.

PIN.—A short shaft, sometimes forming a bolt, a part of which serves as a journal. O. Eng. *pinne*, a 'peg' (brass pins for fastening things together were not introduced into England till 1540), from Lat. *pinna*, 'feather,' a variant of *penna*, from a root meaning 'to fly.' From the sense of *feather* came that of *pen* (the same word as *pin*), and that of *style* for writing on wax, and next that of *peg*, from the resemblance to a style, and finally any sharp pointed piece of wood or metal for fastening things together. *Pin*, then, means literally, 'something for flying with.'

PINION.—A small wheel with teeth working into a larger one or rack. From Fr. *pinion*, from Lat. *pinna*, a 'battlement' on a wall, to which the cogs of the pinion were likened.

PISTON.—A short cylinder working in the chamber of a pump or the cylinder of an engine. From O. Fr. *piston*, 'pestle,' from *pistonem*, accusative case of an unrecorded Low Lat. word derived from Low Lat. *pistare*, 'to pound.' The *piston*, then, is 'the pounder.'

PIVOT.—A pin upon which a wheel or other body turns. From O. Fr. *pivot*, a diminutive formed from Ital. *piva*, 'pipe,' 'tube with a fine bore,' Lat. *pipa*, 'pipe;' finally, by extension of meaning, a solid peg. Thus *pivot* means, literally, 'little pipe.'

PLANE.—A tool for smoothing surfaces of wood. From Fr. *plane*, from Low Lat. *plana*, from *planare*, 'to render a surface plane or level.'

PLIERS.—Pincers for seizing and bending. Formed from *ply*, 'to bend,' with suffix *er*, denoting the agent; Fr. *plier*, 'to bend,' from Lat. *plicare*, 'to roll together.' *Pliers*, then, are 'the benders.'

PUNCH.—An instrument for stamping or perforating metal, etc. Abbreviated from O. Eng. *punchon*, from O. Fr. *poinson*, from Lat. *punctionem*, accusative case of *punctio*, properly, the '*act* of punching,' and then an instrument for performing the act.

RACK.—A *straight* bar provided with teeth. From a root meaning 'to stretch out,' 'lie straight.' *Ratch* (with its diminutive *ratchet*) is a weak form of the word *rack*.

RASP.—A coarse file. From O. Fr. *raspe*, deriv. from *rasper*, 'to grate,' from O. H. Ger. *raspôn*, 'to rake together.' The *rasp* is, literally, 'the scraper.'

SAW.—A tool with a toothed blade for cutting. From Ang. Sax. *saga*, from the root *sag*, 'to cut.' Saw means 'the cutter.'

SCREW.—A cylinder, or cylindrical perforation, provided with a spiral thread. The name was originally applied to the female screw, or nut. O. Eng. *scrowe*, from O. Fr. *escroue*, from Lat. *scrobem*, accusative case of *scrobs*, a word which in classical Latin meant 'ditch,' 'hole,' but which, in Low Latin, particularly designated the hole made in the ground by the twisting motion of the snout of swine; hence 'screwing was originally the boring action of these animals.'

SHAFT.—A bar provided with journals, on which it rests and revolves. The original meaning of the word is 'shaven' rod. Formed from the past participle of Ang. Sax. *scafan*, 'to shave.'

SHEARS.—(1) A cutting instrument. O. Eng. *sheres*, Ang. Sax. *sceara*, from a root meaning 'to cut.' (2) An apparatus for raising heavy weights. O. Eng. *shoriers*, 'shores,' 'props,' a word of Scandinavian origin, meaning 'that which is *shorn* off' to the proper length to serve as a propor*shore*.

SLEDGE.—A heavy hammer. From O. Eng. *slegge*, from Ang. Sax. *slecge*, 'a heavy hammer,' from *slegen*, past participle of *slean*, 'to smite.' Thus *sledge* means 'the smiter.' The compound word *sledge-hammer* is tautological, since it means 'hammer-hammer.'

SOCKET.—A hollow which receives and holds something. A diminutive of *sock*, a 'half-stocking.'

SPINDLE.—A slender rod on which anything turns. O. Eng. *spinl*, Ang. Sax. *spinl*, from *spinnan*, 'to spin.' Originally, the name of the pin from which the thread is *spun*. The sense of the word is 'that which *spins*.'

STIRRUP.—In machinery, any piece that resembles, in shape or functions, the stirrup of a saddle. From Ang. Sax. *stigrap*, 'climb-rope;' originally a looped rope by which to mount into the saddle.

STRUT.—Any part of a machine or structure of which the function is to hold things apart. From Low Ger. *strutt*, 'rigid.' The original sense is 'a stiff piece.'

STUD.—A short rod projecting from something, and sometimes forming a journal. O. Eng. *stode*, from Ang. Sax. *studu*, a 'post,' from the root *sta*, 'to stand.' The original sense is 'that which stands.'

SWIVEL.—A piece fixed to another piece by a pin so as to turn easily. From Ang. Sax. *swifan*, 'to move quickly,' 'to revolve.' The sense is 'that which freely revolves.'

TOOL.—An instrument used by workmen. From O. Eng. *tol*, from Ang. Sax. *tōl*, 'tool.' Formed from Teutonic root *tu*, 'to work,' with suffix *l* denoting the instrument. The original sense is 'that which does work.'

TRUNNION.—A gudgeon on each side of an oscillating steam cylinder. From O. Fr. *trognon*, 'stock,' 'stump,' or 'trunk' of a branchless tree, diminutive of *tronc*, 'trunk,' from Lat. *truncus*, 'trunk' (of a tree). The object derives its name from being compared to a short stump.

VALVE.—The lid or cover to an aperture in a pump or other mechanism. From Fr. *valve*, from Lat. *valva*, the 'leaf' of a folding door; connected with *volvere*, 'to turn round,' or 'about.'

VISE.—An instrument, closed by a *screw*, for holding an object tightly. From Fr. *vis*, a 'screw,' from Lat. *vitis*, the tendril of a vine, spirally formed, then, by assimilation of sense, a screw.

WINCH.—The crank of a wheel or axle. From Ang. Sax. *wince*. The original sense is a 'bend;' hence a bent handle.

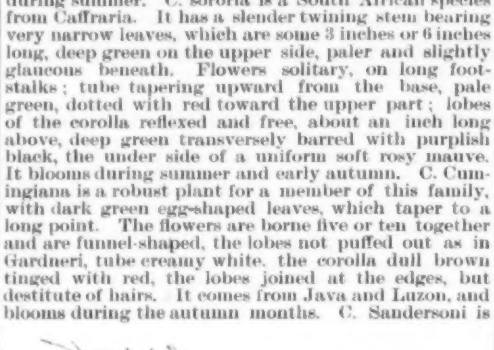
WINDLASS.—An apparatus for raising heavy weights. A corruption of O. Eng. *windas*, from Icel. *vinddss*, meaning, literally, a 'winding-pole,' from *vinda*, 'to wind,' and *dss*, 'pole,' *i. e.*, a cylindrical pole or axis around which a chain or rope winds.

CEROPEGIAS AND THEIR CULTURE.

THE plants belonging to this genus are for the most part small-growing, slender climbers, with tuberous roots. They have a beauty peculiarly their own, but are not frequently found in cultivation, except in gardens where large collections of plants are maintained; this is much to be regretted, as they form charming ornaments, and are excellent companions for the smaller kinds of Aristolochia, such as A. ridicula and A. elegans.

These curious and remarkable plants usually inhabit rough, stony ground, and scramble among the low bushes which are to be found near them. We have found them to be very effective when allowed to grow among sprays of birch or other twigs; these their branches overgrow and festoon in a very pleasing manner, and the flowers show themselves to the best advantage when thus allowed freedom of growth. For soil we have found a mixture of about two parts loam to one of peat, with the addition of some sharp sand and broken brick rubbish, to suit them admirably. Th. temperature of an intermediate house is sufficient for their development, but they enjoy full exposure to sun and light.

The genus contains a great number of species, some of which do not recommend themselves to the horticulturist; the kinds which we enumerate, however, are all distinct and well deserving attention; we have grown handsome specimens of them under the conditions here given. C. Gardneri, from Ceylon, is an elegant twining plant, with stems slightly stouter than a wheat straw; the opposite leaves are borne upon short footstalks, and are between 3 inches and 4 inches long, sharply lanceolate in shape, deep green on the upper side, tinged with slaty purple beneath. The flowers grow in small clusters upon short footstalks, which spring from the base of the leaves, and are about 2 inches long; they are tubular, slightly swollen at the base, with a narrow neck and a large spreading five-lobed limb. These,just before opening, bear a strong resemblance to an open flower of a Stapelia, but when open these lobes remain joined at their points. A good idea of their appearance may be gleaned from the accompanying figure. The flowers are creamy-white, spotted all over with brownish purple like a cheetah; the edges of the lobes are fringed with numerous small hairs which turn inward. It blooms during the greater part of the summer. C. vincæfolia, from Western India, is a more robust plant than the preceding; otherwise it resembles it in general appearance. The tube of the corolla is narrow in the middle, creamy white freckled and dotted with crimson, base of the lobes green; the limb is reflexed, not jointed in the edges, and dull purple in color. It blooms during late summer and through the autumn months. C. Bowkeri, from Caffraria, can scarcely be called a climber, although it delights to grow through and about twiggy brushwood. The stems are very slender, furnished with narrowly linear, opposite leaves some 3 inches in length, and pale green in color. Flowers mostly solitary, borne upon short footstalks; tube of corolla narrow in the middle, brownish purple within; the lobes of the corolla are free, longer than the tube, and reflexed; ground color yellowish green, over which are numerous blisters of emerald green, the edges being ornamented with short hairs. It is a summer bloomer. C. elegans is a plant which much resembles Gardneri in size and habit. The flowers, although similar in shape, are somewhat smaller; they are also more inflated at the base. The neck, which is very narrow, is blackish purple; the limb is united at the edges of the lobes, where they are fringed with long black erect hair. Corolla blackish purple, blotched and spotted with creamy yellow; inside it is sparingly dotted with purple. It comes from the Madras hills, and flowers during summer. C. sororia is a South African species from Caffraria. It has a slender twining stem bearing very narrow leaves, which are some 3 inches or 6 inches long, deep green on the upper side, paler and slightly glaucous beneath. Flowers solitary, on long footstalks; tube tapering upward from the base, pale green, dotted with red toward the upper part; lobes of the corolla reflexed and free, about an inch long above, deep green transversely barred with purplish black, the under side of a uniform soft rosy mauve. It blooms during summer and early autumn. C. Cumingiana is a robust plant for a member of this family, with dark green egg-shaped leaves, which taper to a long point. The flowers are borne five or ten together and are funnel-shaped, the lobes not puffed out as in Gardneri, tube creamy white, the corolla dull brown tinged with red, the lobes joined at the edges, but destitute of hairs. It comes from Java and Luzon, and blooms during the autumn months. C. Sandersoni is



CEROPEGIA ELEGANS.—FLOWERS WHITE, BLOTCHED WITH BROWN.

also a robust plant, with a similar habit to the preceding, but is a native of Natal. The flowers are some two inches long, and are produced throughout the summer months; tube swollen at the base, with a contracted neck and spreading corolla; the lobes are joined at the edges and puffed outward, forming a parasol-like covering to the mouth of the tube: ground color yellowish green spotted with bright green, fringed at the edges with short erect hairs.—*W. H. G., the Garden.*

THE PAST HISTORY OF THE SPECIES OF THE EXISTING FLORA.*

ADDRESS TO THE BIOLOGICAL SECTION.

By WILLIAM CARRUTHERS, Pres. L. S., F.R.S., F.G.S., President of the Section.

IN detaining you a few minutes from the proper work of the section, I propose to ask your attention to what is known of the past history of the species of plants which still form a portion of the existing flora. The relation of our existing vegetation to preceding floras is beyond the scope of our present inquiry; it has been frequently made the subject of exposition, but to handle it requires a more lively imagination than I can lay claim to, or, perhaps, than it is desirable to employ in any strictly scientific investigation.

The literature of science is of little, if any, value in tracing the history of species and in determining the modification or the persistency of characters which may be essential or accidential to them. If help could be obtained from this quarter, botanical inquiry would be specially favored, for the literature of botany is earlier, and its terms have all along been more exact than in any of her sister sciences. But even the latest descriptions, incorporating as they do the most advanced observations of science, and expressed in the most exact terminology, fail to supply the data on which a minute comparison of plants can be instituted. Any attempt to compare the descriptions of Linnæus and the earlier systematists who, under his influence, introduced greater precision into their language with the standard authors of our own day would be of no value. The short, vague, and insufficient descriptions of the still earlier botanists cannot even be taken into consideration.

Greater precision might be expected from the illustrations that have been in use in botanical literature from the earliest times; but these really supply no better help in the minute study of species than the descriptions which they are intended to aid. The earliest illustrations are extremely rude; many of them are misplaced; some are made to do duty for several species, and not a few are purely fictitious. The careful and minutely exact illustrations which are to be found in many modern systematic works are too recent to supply materials for detecting any changes that may have taken place in the elements of a flora.

But the means of comparison which we look for in vain in the published liturature of science may be found in the collections of dried plants which botanists have formed for several generations. The local herbaria of our own day represent not only the different species found in a country, but the various forms which occur, together with their distribution. They must supply the most certain materials for the minute comparison at any future epoch of the then existing vegetation with that of our own day.

The preservation of dried plants as a help in the study of systematic botany was first employed in the middle of the sixteenth century. The earliest herbarium of which we have any record is that of John Falconer, an Englishman who traveled in Italy between 1540 and 1547, and who brought with him to England a collection of dried plants fastened in a book. This was seen by William Turner, our first British botanist, who refers to it in his Herbal, published in 1551. Turner may have been already acquainted with this method of preserving plants, for in his enforced absence from England he studied at Bologna under Luca Ghini, the first professor of botany in Europe, who, there is reason to believe, originated the practice of making herbaria. Ghini's pupils, Aldrovandus and Cæsalpinus, formed extensive collections. Caspar Bauhin, whose "Prodromus" was the first attempt to digest the literature of botany, left a considerable herbarium, still preserved at Basle. No collection of English plants is known to exist older than the middle of the seventeenth century; a volume containing some British and many exotic plants collected in the year 1647 was some years ago acquired by the British Museum. Toward the end of that century, great actvity was manifested in the collection of plants, not only in our own country, but in every district of the globe visited by travelers. The labors of Ray and Sloane, of Petiver and Plukenet, are manifest not only in the works which they published, but in the collections that they made, which were purchased by the country in 1759, when the museum of Sir Hans Sloane became the nucleus of the now extensive collections of the British Museum. The most important of these collections in regard to British plants is the herbarium of Adam Buddle, collected nearly two hundred years ago, and containing an extensive series which formed the basis of a British Flora that, unhappily for science, was never published, though it still exists in manuscript. Other collections of British plants of the same age, but less complete, supplement those of Buddle. These various materials are in such a state of preservation as to permit of the most careful comparison with living plants, and they show that the two centuries which have elapsed since their collection have not modified in any particular the species contained in them. The early collectors contemplated merely the preservation of a single specimen of each species; consequently the data for an exhaustive comparison of the indigenous flora of Britain at the beginning of last century with that of the present are very imperfect as compared with those which we shall hand down to our successors for their use.

The collections made in other regions of the world in the seventeenth century, and included in the extensive herbarium of Sir Hans Sloane, are frequently being examined side by side with plants of our own day, but they do not show any peculiarities that distinguish them from recent collections. If any changes are taking place in plants, it is certain that the three hundred years during which their dried remains have been preserved in herbaria have been too short to exhibit them.

Beyond the time of those early herbaria, the materials which we owe in any way to the intervention of man have been preserved without any regard to their scientific interest. They consist mainly of materials used in building or for sepulture. The woods employed in mediæval buildings present no peculiarities by which they can be distinguished from existing woods; neither do the woods met with in Roman and British villages and burying places. From a large series collected by General Pitt-Rivers in extensive explorations carried on by him on the site of a village which had been occupied by the British before and after the appearance of the Romans, we find that the woods chiefly used by them were oak, birch, hazel, and willow, and at the latter period of occupation of the village the wood of the Spanish chestnut (Castanea vulgaris, Lamk.) was so extensively employed that it must have been introduced and grown in the district. The gravel beds in the north of London, explored by Mr. W. G. Smith for the palæolithic implements in them, contained also fragments of willow and birch and the rhizomes of Osmunda regalis, L.

The most important materials, however, for the comparison of former vegetation of a known age with that of our own day have been supplied by the specimens which have been obtained from the tombs of the ancient Egyptians. Until recently these consisted mainly of fruits and seeds. These were all more or less carbonized, because the former rifling of the tombs had exposed them to the air. Ehrenberg, who accompanied Von Minutoli in his Egyptian expedition, determined the seeds which he had collected; but as he himself doubted the antiquity of some of the materials on which he reported, the scientific value of his enumeration is destroyed. Passalacqua, in 1823, made considerable collections from tombs at Thebes, and these were carefully examined and described by the distinguished botanist Kunth. He pointed out, in a paper published sixty years ago, that these ancient seeds possessed the minute and apparently accidential peculiarities of their existing representatives. Unger, who visited Egypt, published in several papers identifications of the plant remains from the tombs; and one of the latest labors of Alexander Braun was an examination of the vegetable remains in the Egyptian Museum at Berlin, which was published, after his death, from his manuscript, under the careful editorship of Ascherson and Magnus. In this, twenty-four species were determined, some from imperfect materials, and necessarily with some hesitation as to the accuracy of their determination.

The recent exploration of unopened tombs belonging to an early period in the history of the Egyptian people has permitted the examination of the plants in a condition which could not have been anticipated. And, happily, the examination of these materials has been made by a botanist who is thoroughly acquainted with the existing flora of Egypt, for Dr. Schweinfurth has for a quarter of a century been exploring the plants of the Nile valley. The plant remains were included within the mummy wrappings, and being thus hermetically sealed, have been preserved with scarcely any change. By placing the plants in warm water, Dr. Schweinfurth has succeeded in preparing a series of specimens gathered four thousand years ago, which

* Proceedings of the British Association for the Advancement of Science, 1886.

are as satisfactory for the purposes of science as any collected at the present day. These specimens consequently supply means for the closest examination and comparison with their living representatives. The colors of the flowers are still present, even the most evanescent, such as the violet of the larkspur and knapweed and the scarlet of the poppy; the chlorophyl remains in the leaves, and the sugar in the pulp of the raisins. Dr. Schweinfurth has determined no less than fifty-nine species,* some of which are represented by the fruits employed as offerings to the dead, others by the flowers and leaves made into garlands, and the remainder by branches on which the body was placed, and which were inclosed within the wrappings.

The votive offerings consist of the fruits, seeds, or stems of twenty-nine species of plants. Three palm fruits are common—the Medemia Argun, Würt., of the Nubian Desert and the Hyphœne thebaica, Mart., of Upper Egypt, agreeing exactly with the fruits of these plants in our own day; also dates of different forms, resembling exactly the varieties of dried dates found now in the markets of Egypt. Two figs are met with, Ficus carica, L., and Ficus sycomorus, L., the latter exhibiting the incisions still employed by the inhabitants for the destruction of the Neuropterous insects which feed on them. The sycamore was one of the sacred trees of Egypt, and the branches used for the bier of a mummy found at Abd-el-Qurna, of the twentieth dynasty (a thousand years before the Christian era), were moistened and laid out by Dr. Schweinfurth, equaling, he says, the best specimens of this plant in our herbaria, and consequently permitting the most exact comparison with living sycamores, from which they differ in no respect. The fruit of the vine is common, and presents, besides some forms familiar to the modern grower, others which have been lost to cultivation. The leaves which have been obtained entire exactly agree in form with those cultivated at the present day, but the under surface is clothed with white hairs, a peculiarity Dr. Schweinfurth has not observed in any Egyptian vines of our time. A very large quantity of linseed was found in a tomb at Thebes of the twentieth dynasty, now three thousand years old, and a smaller quantity in a vase in another tomb of the twelfth dynasty, that is, one thousand years older. This belongs certainly to Linum humile, Mill., the species still cultivated in Egypt, from which the capsules do not differ in any respect. Braun had already determined this species preserved thus in the tombs, though he was not aware of its continued cultivation in Egypt. The berries of Juniperus phœnicea, L., are found in a perfect state of preservation, and present a somewhat larger average size than those obtained from this juniper at the present day. Grains of barley and wheat are of frequent occurrence in the tombs; M. Mariette has found barley in a grave at Sakhara of the fifth dynasty, five thousand four hundred years old.

The impurities found with the seeds of these cultivated plants show that the weeds which trouble the tillers of the soil at the present day in Egypt were equally the pests of their ancestors in those early ages. The barley fields were infested with the same spiny medick (Medicago denticulata, Willd.) which is still found in the grain crops of Egypt. The presence of the pods of Sinapis arvensis, L., among the flax seed testifies to the presence of this weed in the flax crops of the days of Pharaoh, as of our own time. There is not a single field of flax in Egypt where this charlock does not abound; and often in such quantity that its yellow flowers, just before the flax comes into bloom, present the appearance of a crop of mustard. The charlock is Sinapis arvensis, L., var. Allionii, Jacq., and is distinguished from the ordinary form by its globular and inflated silicules, which are as characteristically present in the ancient specimens from the tombs as in the living plants. Rumex dentatus, L., the dock of the Egyptian fields of to-day, has been found in graves of the Greek period at Dra-Abu-Negga.

It is difficult without the actual inspection of the specimens of plants employed as garlands, which have been prepared by Dr. Schweinfurth, to realize the wonderful condition of preservation in which they are. The color of the petals of Papaver Rhœas, L., and the occasional presence of the dark patch at their bases, present the same peculiarities as are still found in this species growing in Egyptian fields. The petals of the larkspur (Delphinium orientale, Gay) not only retain their reddish-violet color, but present the pecular markings which are still found in the living plant. A garland composed of wild celery (Apium graveolens, L.) and small flowers of the blue lotus (Nymphœa cœrulea, Sav.), fastened together by fibers of papyrus, was found on a mummy of the twentieth dynasty, about three thousand years old. The leaves, flowers, and fruits of the wild celery have been examined with the greatest care by Dr. Schweinfurth, who has demonstrated in the clearest manner their absolute identity with the indigenous form of this species now abundant in moist places in Egypt. The same may be said of the other plants used for garlands, including two species of lichens.

It appears to have been a practice to lay out the dead bodies on a bier of fresh branches, and these were inclosed within the linen wrappings which enveloped the mummy. In this way there have been preserved branches of considerable size of Ficus sycomorus, L., Olea europœa, L., Mimusops schimperi, H., and Tamarix nilotica, Ehrb. The mimusops is of frequent occurrence in the mural decorations of the ancient temples; its fruit had been detected among the offerings to the dead, and detached leaves had been found made up into garlands, but the discovery of branches with their leaves still attached, and in one case with the fruit adhering, has established that this plant is the Abyssinian species to which Schimper's name had been given, and which is characterized by the long and slender petiole of the leaf.

In none of the species, except the vine to which I have referred, which Dr. Schweinfurth has discovered, and of which he has made a careful study, has he been able to detect any peculiarities in the living plants which are absent in those obtained from the tombs.

Before passing from these Egyptian plants I would draw attention to the quality of the cereals. They are good specimens of the cereals still cultivated. This observation is true also of the cultivated grains which I have examined, belonging to prehistoric times. The wheat found in the purely British portion of the ancient village explored by General Pitt-Rivers is equal to the average of wheat cultivated at the present day. This is the more remarkable, because the two samples from the later Romano-British period obtained by General Pitt-Rivers are very much smaller, though they are not unlike the small hard grains of wheat still cultivated on thin chalk soils. The wheat from lake dwellings in Switzerland, for which I am indebted to J. T. Lee, Esq., F.G.S., are fair samples. My colleague, Mr. W. Fawcett, has recently brought me from America grains of maize from the prehistoric mounds in the valley of the Mississippi, and from the tombs of the Incas of Peru, which represent also fair samples of this great food substance of the New World. The early peoples of both worlds had then under cultivation productive varieties of these important food-plants, and it is remarkable that in our own country, with all the appliances of scientific cultivation and intelligent farming, we have not been able to appreciably surpass the grains which were harvested by our rude ancestors of two thousand years ago.

In taking a further step into the past, and tracing the remains of existing species of plants preserved in the strata of the earth's crust, we must necessarily leave behind all certain chronology. Without an intelligent observer and recorder there can be no definite determination of time. We can only speculate as to the period required for effecting the changes represented by the various deposits.

The peat bogs are composed entirely of plant remains belonging to the floras existing in the regions where they occur. They are mainly surface accumulations still being formed and going back to an unknown antiquity. They are subsequent to the last changes in the surface of the country, and represent the physical conditions still prevailing.

The period of great cold during which Arctic ice extended far into temperate regions was not favorable to vegetable life. But in some localities we have stratified clays with plant remains later than the glacial epoch, yet indicating that the great cold had not then entirely disappeared. In the lacustrine beds at Holderness is found a small birch (Betula nana, L.), now limited in Great Britain to some of the mountains of Scotland, but found in the Arctic regions of the Old and New World and on Alpine districts in Europe, and with it Prunus padus, L., Quercus robur, L., Corylus avellana, L., Alnus glutinosa, L., and Pinus sylvestris, L. In the white clay beds at Bovey Tracey of the same age there occur the leaves of Arctostaphylos uva-ursi, L., three species of willow, viz., Salix cinerea, L., S. myrtilloides, L., and S. polaris, Wahl., and in addition to our Alpine Betula nana, L., the more familiar B. alba, L. In beds of the same age in Sweden, Nathorst has found the leaves of Dryas octopetala, L., and Salix herbacea, L., this being associated with S. polaris, Wahl. Two of these plants have been lost to our flora from the change of climate that has taken place, viz., Salix myrtilloides, L., and S. polaris, Wahl.; and Betula nana, L., has retreated to the mountains of Scotland. Three others (Dryas octopetala, L., Arctostaphylos uva-ursi, L., and Salix herbacea, L.) have withdrawn to the mountains of northern England, Wales, and Scotland, while the remainder are still scattered over the country. Notwithstanding the diverse physical conditions to which these plants have been subjected, the remains preserved in these beds present no characters by which they can be distinguished from the living representatives of the species.

We meet with no further materials for careful comparison with existing species until we get beyond the great period of intense cold which immediately preceded the present order of things. The glacial epoch includes four periods during which the cold was intense, separated by intervals of somewhat higher temperature, which are represented by the intervening sedimentary deposits. During these alterations of temperature, extensive changes in the configuration of the land were taking place. The first great upheaval occurred in the early glacial period, and was followed by a considerable subsidence. A second upheaval took place late in the glacial epoch. Various estimates have been formed of the time required for this succession of climatic conditions and earth movements. The moderate computation of Ramsay and Lyell gives to the bowlder clay of the first glacial period an age of 250,000 years, estimating the time of the first upheaval as 200,000 years ago, while the subsidence took place 50,000 years later, and the second upheaval 92,000 years ago.

The sedimentary deposits later than the Pliocene strata, but older than the glacial drift, indicate an increasing severity in the climate, which reached its height in the first glacial period.

At Cromer, on the Norfolk coast, the newest of these deposits has supplied the remains of Salix polaris, Wahl., S. cinerea, L., and Hypnum turgescens, Schimp. This small group of plants is of great interest in connection with the history of existing species. Their remains are preserved in such a manner as to permit the closest comparison with living plants. Such an examination shows that they differ from each other in no particular. In the post-glacial deposits in Sweden, Salix herbacea, L., is associated with S. polaris, Wahl., as I have already stated. These two willows are very closely related, having, indeed, been treated as the same species until Wahlenberg pointed out the characters which separated them when he established Salix polaris as a distinct species in 1812. One of the most obvious of the specific distinctions is the form and the venation of the leaf, a character which is, however, easily overlooked, but when once detected is found to be so constant that it enables one to distinguish without hesitation the one species from the other. The leaves of the two willows in the Swedish bed present all the peculiarities which they possess at the present day, and the venation and form of the leaves of S. polaris, Wahl., from the pre-glacial beds of Cromer, present no approach toward the peculiarities of its ally, S. herbacea, L., but exhibit them exactly as they appear in the living plant. This is the more noteworthy, as the vegetative organs supply, as a rule, the least stable of the characters employed in the diagnosis of species. The single moss (Hypnum turgescens, Schimp.) is no longer included in the British flora, but is still found as an Arctic and Alpine species in Europe, and the pre-glacial specimens of this cellular plant differ in no respect from their living representatives.

The older beds containing the remains of existing species, which are found also at Cromer, have recently been explored with unwearied diligence and great success by Mr. Clement Reid, F.G.S., an officer of the Geological Survey of England. To him I am indebted for the opportunity of examining the specimens which he has found, and I have been able to assist him in some of his determinations, and to accept all of them. His collections contain sixty-one specimens of plants belonging to forty-six different genera, and of these forty-seven species have been identified. Slabs of clay ironstone from the beach at Happisburgh contain leaves of beach, elm, oak, and willow. The materials, however, which have enabled Mr. Reid to record so large a number of species are the fruits or seeds which occur chiefly in mud or clay, or in the peat of the forest bed itself. The species consist mainly of water or marsh plants, and represent a somewhat colder temperature than we have in our own day, belonging as they do to the Arctic facies of our existing flora.

Only one species (Trapa natans, L.) has disappeared from our islands. Its fruits, which Mr. Reid found abundantly in one locality, agree with those of the plants found until recently in the lakes of Sweden. Four species (Prunus spinosa, L., Œnanthe lachenalii, Gmel., Potamogeton heterophyllus, Schreb., and Pinus Abies, L.) are found at present only in Europe, and a fifth (Potamogeton trichoides, Cham.) extends also to North America; two species (Peucedanum palustre, Moench, and Pinus sylvestris, L.) are found also in Siberia; while six more (Sanguisorba officinalis, L., Rubus fruticosus, L., Cornus sanguinea, L., Euphorbia amygdaloides, L., Quercus robur, L., and Potamogeton crispus, L.) extend into Western Asia, and two (Fagus sylvatica, L., and Alnus glutinosa, L.) are included in the Japanese flora. Seven species, while found with the others, enter also into the Mediterranean flora, extending to North Africa. These are Thalictrum minus, L., Thalictrum flavum, L., Ranunculus repens, L., Stellaria aquatica, Scop., Corylus avellana, L., Zannichellia palustris, L., and Cladium mariscus, Br. With a similar distribution in the Old World, eight species (Bidens tripartita, L., Myosotis cæspitosa, Schultz., Suæda maritima, Dum., Ceratophyllum demersum, L., Sparganium ramosum, Huds., Potamogeton pectinatus, L., Carex paludosa, Good., and Osmunda regalis, L.) are found also in North America. Of the remainder, ten species (Nuphar luteum, Sm., Menyanthes trifoliata, L., Stachys palustris, L., Rumex maritimus, L., Rumex Acetosella, L., Betula alba, L., Scirpus paucifloras, Lightf., Taxus baccata, L., and Isoetes lacustris, L.) extend round the north temperate zone, while three (Lycopus europæus, L., Alisma plantago, L., and Phragmites communis, Trin.), having the same distribution in the north, are found also in Australia, and one (Hippuris vulgaris, L.) in the south of South America. The list is completed by Ranunculus aquatilis, L., distributed over all the temperate regions of the globe, and Scirpus lacustris, L., which is found in many tropical regions as well.

The various physical conditions which necessarily affected these species in their diffusion over such large areas of the earth's surface in the course of, say, 250,000 years should have led to the production of many varieties, but the uniform testimony of the remains of this considerable pre-glacial flora, as far as the materials admit of a comparison, is that no appreciable change has taken place.

I am unable to carry the history of any existing species of plant beyond the Cromer deposits. Some of the plant remains from Tertiary strata have been referred to still living species, but the examination of the materials, as far as they have come before me, convinces me that this has been done without sufficient evidence. The physical conditions existing during even the colder of the Tertiary periods were not suitable to a flora fitted to persist in these lands in our day, even if the period of great cold had not intervened to destroy them. And in no warmer region of the earth do these Tertiary periods now exist, though floras of the same facies occur, containing closely allied species. The sedimentary beds at the base of the glacial epoch contain, as far as we at present know, the earliest remains of any existing species of plant.

It is not my purpose to point out the bearing of these facts on any theoretical views entertained at the present day. I wish merely to place them before the members of this section as data which must be taken into account in constructing such theories, and as confirming the long-established axiom that by us, at least, as workers, species must by dealt with as fixed quantities.

* List of the species of ancient Egyptian plants determined by Dr. Schweinfurth. I am indebted to Dr. Schweinfurth for some species in this list, the discovery of which he has not yet published.
Delphinium orientale, Gay; Cocculus Leæba, DC.: Nymphœa cœrulea, Sav.; Nymphœa Lotus, Hook.; Papaver Rhœas, L.; Sinapis arvensis, L., var. Allionii, Jacq.; Mœrua uniflora, Vahl.; Oncoba spinosa, Forsk.; Tamarix nilotica, Ehrb.; Alcea ficifolia, L.; Linum humile, Mill.; Balanites œgyptiaca, Del.; Vitis vinifera, L.; Moringa aptera, Gærtn.; Medicago denticulata, Willd.; Sesbania œgyptiaca, Pers.; Faba vulgaris, Moench; Lens esculenta, Moench; Lathyrus sativus, L.; Cajanus indicus, L.; Acacia nilotica, Del.; Lawsonia inermis, Lamk.; Punica granatum, L.; Epilobium hirsutum, L.; Lagenaria vulgaris, Ser.; Citrullus vulgaris, Schrad., var. colocynthoides, Schweinf.; Apium graveolens, L.; Coriandrum sativum, L.; Ceruana pratensis, Forsk.; Sphœranthus suaveolens, DC.; Chrysanthemum coronarium, L.; Centaurea depressa, M. Bieb.; Carthamus tinctorius, L.; Picris coronopifolia, Asch.; Mimusops Schimperi, Hochst.; Jasminum sambac, L.; Olea europœa, L.; Mentha piperita, L.; Rumex dentatus, L.; Ficus Sycomorus, L.; Ficus carica, L.; Salix safsaf, Forsk.; Juniperus phœnicea, L.; Pinus pinea, L.; Allium sativum, L.; Allium Cepa, L.; Phœnix dactylifera, L.; Calamus fasciculatus, Roxb.; Hyphœne thebaica, Mart.; Medemia argun, P. G. v. Würtemb.; Cyperus papyrus, L.; Cyperus esculentus, L.; Andropogon laniger, Desf.; Leptochloa bipinnata, Retz.; Triticum vulgare, L.; Hordeum vulgare, L., Parmelia furfuracea, Ach.; Usnea plicata, Hoffm.

THE MOTIONS OF THE EARTH.

To the Editor of the Scientific American:

Mr. Adynors, in SCIENTIFIC AMERICAN SUPPLEMENT, No. 562, gives a new theory of certain motions of the earth. Will you kindly permit me, through your columns, to present to my fellow readers of the SCIENTIFIC AMERICAN another new theory, which I have formulated, and which, while quite different to that of the textbooks, accounts for all the phenomena taught in them, and much more in addition thereto.

1. In this theory, the plane of the sun's equator is the datum plane, and called the great plane. All on the side next the north pole, as we term it, is called above, all on the south side is called below.

2. The earth's orbit is an ellipse, the sun being in the lower focus.

3. The plane of the orbit lies at present at an angle of less than 23½° to the great plane.

4. A line drawn across the orbit through the sun, at a right angle to the major axis of the orbit, is called the minor axis.

5. The orbit revolves around both axes.

6. The orbit lies partly above and partly below the great plane. At the two points where it intersects the plane, are the ascending and descending nodes.

7. The axis of the earth is always approximately parallel with the sun's axis.

8. When at either node, the plane of the earth's equator coincides with the plane of the sun's equator. The two hemispheres are then equally lighted by the sun's rays, and day and night are equal.

9. If a line be drawn from the center of the sun to the center of the earth, when at, say, the autumnal or ascending node, the line will cut both equators, and at the earth's equator the sun will be overhead. Then as the earth passes up on its course the line will pass below the earth's equator, southward, until the part of the orbit highest above the great plane be reached. Then the line will return northward, until the earth is at the descending node, when the sun is again overhead. The line of the limit of sunshine will be similarly moved north or south.

10. The orbit, revolving on both axes, brings the earth continually into a new position relative to both the sun and the stars. At each return of the earth to the nodes, the orbit revolving on its axes, the intersection has moved along the great plane and both the plane and the orbit intersect in new places, thus producing a procession of the nodes.

From these motions there results a great variety of positions.

A. The plane of the orbit coinciding with the plane of the sun's equator, the earth would have throughout the year equal day and night, and continual summer in both hemispheres, with no variation of seasons.

B. The plane of the earth's orbit parallel to the sun's axis would give three months of unbroken summer and the same of winter, and at the poles a like period of continuous day, the sun reaching the zenith there.

C. The usual division of the seasons into four parts having definite limits is not indicated by the earth's positions. Two divisions are definitely determined by the positions above and below the great plane. When the earth is above the great plane, the southern hemisphere receives the larger portion of the sun's rays; when below, the northern hemisphere receives the greater portion, the greatest departure above or below being midsummer and midwinter. Spring and autumn are periods of effect varying in time of occurrence and duration according to latitude.

D. When the earth is above the great plane, it is directly under the electrical influence of the north pole of the sun; when below, the south pole of the sun controls. At the nodes there must be a change of polarity in the earth's electricity. These changes may be either violently or quietly made.

E. The sun being a central magnet and each planet also a magnet, the planets' approach and recession to and from the sun, and each other, and the coming into line of three or more of these electrically charged bodies, must produce a variety of electric disturbances in all members of the system.

F. When the plane of the minor axis lies in the plane of the sun's equator, aphelion and perihelion are midway between the nodal points, and the longest and shortest days coincide with aphelion and perihelion, and will also coincide with the highest and lowest points of the orbit.

G. Spots on the sun viewed from the earth, at the nodes, appear to travel in a straight line across the disk. Viewed from any other position, they will apparently travel in a curved line, the curve being greater or less as the earth may be higher or lower, above or below the great plane.

H. The decreasing of the angle between the major axis of the orbit and the great plane causes the declination of the sun to diminish. The departure above and below being lessened thereby, the climatic result being an advance of the cold region toward the equator.

An examination of these positions suggests that the minor axis lay in the plane of the sun's equator at the time when the constellations occupied their signs—the nodes, the minor axis, and the first point, Aries, coinciding. How was the first point, Aries, established? By whom and when?

In the position described at A, the entire globe might be habitable. In the position at B, the poles would have more than tropical heat, following winters of now unknown severity. The sudden melting of ice and snow would produce great floods unequaled in our days.

To study the consequent climatic probabilities in the past, present, and future resulting from the various possible relative positions of the earth and sun, offered by this theory, may give to some of your readers as much pleasant entertainment as I have found in the formation of the theory.

Jos. Voyle.

Gainesville, Fla.

NODON'S GELATINE HYGROMETER.

Meteorology already owes a great part of its present progress to registering apparatus that permit of following the phenomena of the atmosphere step by step, so to speak. Among all such instruments, hygrometers alone have been uncertain in their operation, and their indications subject to numerous causes of error. It will be understood, then, how profitable it would prove to have a registering hygrometer that should be accurate in its indications, sensitive, and prompt in its action. This is a desideratum that appears to have been supplied by Mr. Albert Nodon, as it seems from a note recently presented to the Academy of Sciences by Mr. Lippmann.

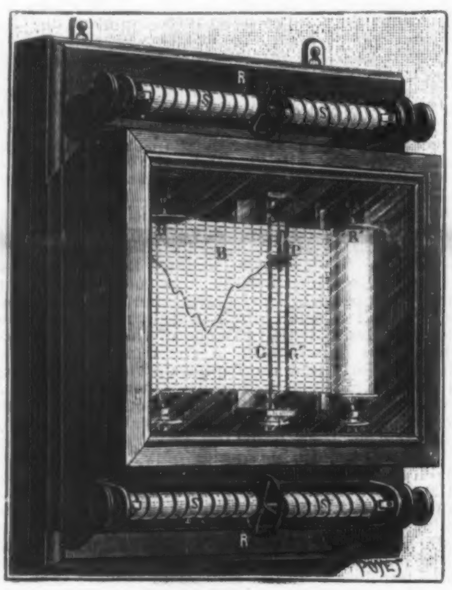
There are, as well known, two very distinct kinds of hygrometers. In the first place, we have condensation ones, such as those of Daniell, Regnault, Alluard, Bourbouge, and others, which furnish very accurate indications, but which, unfortunately, necessitate quite a delicate manipulation, and which are scarcely utilizable as registering apparatus. The second are absorption hygrometers, the action of which is based upon the property possessed by certain substances (such as hairs, horn, wood, ivory, etc.) of becoming more or less distorted in an atmosphere of varying humidity. These devices are easily used, and can be readily employed in the construction of a registering apparatus. Unfortunately, the distortions that they undergo are in most cases variable with the temperature, and the material of which they are formed undergoes an alteration in time that falsifies the instrument's indications.

It became a question, then, to find a hygroscopic substance that should permit of constructing a hygrometer giving just as accurate and rapid indications as are furnished by condensation apparatus, and being as simple as absorption ones, and in addition, a substance that should undergo no distortion under the influence of the temperature, and that should last as long as possible, its hygroscopic properties not being modified by time.

There is one material which possesses all these properties to the highest degree, and that is gelatine. This substance, which can be rendered unchangeable by adding to it a small amount of salicylic acid, absorbs an amount of water that is proportional to the hygrometric state of the air, and increases in weight and bulk proportionally to such state. These properties are independent of the temperature between the observed limits of from 10° to 35° C.

These remarkable properties of gelatine have been applied by Mr. Nodon in the construction of a hygrometer as follows: If we spread gelatine over a strong paper or Bristol board spiral, whose interior is protected by some hygroscopic substance, such as bitumen, we shall obtain a device which is sensitive to variations in the hygrometric state of the air, and one which is analogous, as regards operation, to the spiral of Breguet's metallic thermometer. When the hygrometric state rises, the gelatine elongates and the spiral unwinds.

It will at once be seen that we might obtain analogous results with hygroscopic substances other than gelatine—such, for example, as gum tragacanth, gum arabic, dextrine, etc., spread in thin coats upon some support other than paper, such as celluloid, ebonite, glass, and the like. But, among all the substances that are applicable, gelatine and paper have given the



NODON'S REGISTERING HYGROMETER.

best results, and so Mr. Nodon has selected them to the exclusion of all others.

His registering apparatus consists of four gelatine paper spirals, S S S S, mounted in pairs upon the same base. One of the extremities of each is held in a clamp, while the other and free extremity acts directly upon a pulley, R. These four spirals, with their combined action, constitute, as a whole, a device that operates with greater regularity than would one with a single spiral. Over the two pulleys, R R, which are arranged in the same vertical line, runs a silk thread to which is attached a small and very light slider, P, that moves between two guides, G G'. It is upon this slider that is arranged the inscribing style. The whole is balanced by a small counterpoise on that portion of the thread that is in the rear.

We thus have a contrivance that is movable in a vertical direction, and capable of obeying the least rotary motion of the spirals. The style bears against a band of ruled paper, B, which unwinds from the roller, R', and winds upon the roller, R, which latter is slowly moved by a clockwork that causes the paper to advance three-quarters of an inch per hour. By selecting a sufficiently thin paper, a great enough length can be wound upon the cylinder to allow the apparatus to operate for ten consecutive days. As the thickness of the paper wound around R increases very slightly with respect to the latter's diameter, we may admit with sufficient approximation that the lengths of paper unwound during an hour's time remain constantly equal to one another.

The clockwork is inclosed in the base of the apparatus. The paper, roller, and pen are protected by a glass plate that can be removed at will. The four spirals operate in the atmosphere, but may, however, be protected by means of wire gauze or a jacket perforated so as to allow the air to circulate freely within.

After plans by the inventor, Mr. Ducretet has constructed a model provided with a dial, which is very convenient for use, and the simplicity of which permits of its being offered to the trade at so low a price as to put it within the reach of all. The external extremity of a sheet-gelatine spiral is fixed in a small metallic box, while the inner extremity of the same causes a needle to move over a dial. This apparatus, which reminds one, externally, of aneroid barometers, is remarkably sensitive and accurate.

An analogous model, constructed by the inventor in April, 1885, was left till June, 1886, in a laboratory, and was, during this epoch, frequently compared with an Alluard hygrometer. The indications were found to be exactly the same, and the spiral had therefore during this space of time undergone no change in its hygroscopic properties. In another model, provided with a spiral of very numerous revolutions, the sensitiveness so increased that the least variations in the hygroscopic state of the surrounding air, which had absolutely no influence upon other hygrometers, even the most sensitive ones, caused a motion of the needle.

From numerous observations, it has been concluded that the indications furnished by the hygrometer are, in most cases, more certain than those given by the barometer. This important fact has led Mr. Ducretet to inscribe the probable state of the weather opposite the graduations on the dial of his hygrometer, thus allowing of the apparatus being used as a weather indicator.—*La Nature.*

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